

CHEMICAL & METALLURGICAL ENGINEERING

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
SIDNEY D. KIRKPATRICK
Assistant Editor

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 25

New York, July 20, 1921

Number 3

Culture in

Technical Education

AT THE twenty-ninth annual meeting of the Society for the Promotion of Engineering Education held at Yale University a few weeks ago, Prof. WILLIAM H. BURR, formerly professor of civil engineering in Columbia University, criticized the society for what he regarded as neglect to bring engineering education to such a plane that engineering as a profession would be elevated to a parity with law and medicine. The burden of his criticism was that the present four-year course in engineering, as given at most institutions, is quite inadequate to enable the graduate to command professional respect or discharge his highest duties as an engineer and a citizen. Characterizing the four-year course as a "college scientific course" and admitting that it had served a good purpose, he contended nevertheless that the time has arrived when a greater proportion of liberal arts must be mixed with science and engineering in order to reach a higher goal for engineers. He advocated a six-year course following high school preparation, devoting three years to liberal arts and three to engineering.

The subject has been before engineers and engineering teachers long enough so that more should have been accomplished than is evident. We are reminded of MARK TWAIN'S comment on the weather, when he said that everybody was always talking about it but nobody ever did anything about it. The situation in engineering education is not exactly parallel, because something has been done. The six-year course is established at Columbia University and other institutions have their combination undergraduate and graduate plans. For the most part, however, the four-year course prevails.

Prof. BURR has our support and approval. When the subject was still in the abstract we were convinced on general principles, supported by observation, that engineering and technical graduates were losing necessary breadth and culture through too close confinement to technical studies. It was apparent even then that a change would not be effected save by heroic action on the part of college faculties, because the necessity for study of the liberal arts could not be appreciated by young students. They were restive under instruction in subjects which had no apparent "practical" bearing. They itched to get into the field. But broad vision and sound counsel have prevailed in some quarters and the student is being better educated in spite of his personal predilection.

Considering the engineer as a citizen, we think that he can rise to even higher places of authority and responsibility than are now held by the lawyer and physician and that the community can learn to look up to him with greater confidence and assurance than they now show toward our public servants. But this will not be possible unless the engineer is given a broader

foundation than can possibly be built on technical studies. The lack may not be apparent in the first few years out of college, when competition for professional recognition and preferment is keen, but at forty the liberally educated engineer will surpass and excel his narrowly trained colleague, not only in general affairs of life but perhaps in engineering as well. The problem before the Society for the Promotion of Engineering Education, as we see it, is to discover those fundamentals in engineering education that will produce men who in their mature years will command not only professional respect from their colleagues but also recognition and approval from society in general. The details of the course of instruction can then be left to individual educators.

Ford Proposes to Buy Government Nitrate Plant

UNUSUAL interest attaches to the offer of HENRY FORD to purchase Nitrate Plant No. 2 at Muscle Shoals and to lease the Wilson dam. The disposition of these war-time projects has been a matter of great concern to the War Department on account of the vast sums already invested and the additional millions required to complete the dam and power plant. Our readers will recall that one solution proposed by Secretary Baker was the creation of the United States Fixed-Nitrogen Corporation to acquire and operate the nitrate plant, the dam and power plant to be completed at Government expense. Congress refused to create the proposed corporation, and declined to appropriate further money for the completion of the dam, work on which was stopped last Spring. With the change of administration Secretary Weeks finally announced that the nitrate plants would be retained under Army control in the most economical standby condition, but that he would not recommend an appropriation, estimated at about thirty million dollars, for the completion of the dam unless he could find private business interests that would assure him of the commercial utility of the project and agree to take it over and operate it when completed. Under such conditions he expressed himself as willing to recommend the necessary appropriation by Congress.

It is too early to determine whether Mr. Ford's proposal in detail will be satisfactory to the Secretary, though on its face it appears to conform to the announced requirements and will call for sincere consideration.

A number of interesting speculations may be indulged in. Has Mr. Ford definitely allied himself with the agricultural interests that have been urging Government operation of the nitrate plants for the production of fertilizer? Will his definite offer lend encouragement to the Congressional bloc that has

shown non-partisan strength in agricultural matters? How will Congress look upon Mr. Ford's offer in the light of its previous defeat of proposed legislation looking to the formation of a corporation to operate the nitrate plant and appropriation for continuance of work on the dam? It looks as though Congress and Secretary Weeks would be embarrassed if they now refuse to entertain this bona fide offer from a private source.

Seen Through Friendly Eyes

IT IS not so many years since it was a fixed habit of a few critical travelers from Europe to come to this country for a few days, and after seeing New York City and Niagara Falls return home to write their impressions. Probably there was an equal number of Americans who were guilty of the same performance in regard to Europe. Having made a few isolated observations, they promptly drew general conclusions which illustrated mainly their lack of intelligence. Conditions are much improved today, however, because people on both sides of the Atlantic have taken pains to see more of the countries they visit. Intelligent Europeans no longer think they are in the West when they reach Pittsburgh—in this respect surpassing some of our natives. Nor do Americans think that they have seen England or France through a business trip to London or Paris.

It is always refreshing to read the impressions of an intelligent and alert visitor who is familiar enough with conditions at home to enable him to make his comparisons and draw his conclusions rationally. If it so happens that he is of our trade or profession, the more interested are we in his observations on things in general, because we may assume that he sees them through eyes trained much like our own. Accordingly we looked forward with pleasure—and were not disappointed—to the impressions of ERNEST J. P. BENN, of the *Chemical Age*, London, who made a recent business tour of the United States. In a delightful address before the New York Business Publishers Association Mr. BENN gave an intimate view of industrial conditions in England, and after he returned home he published in the *Chemical Age* a very frank and illuminating statement of his impressions regarding ourselves. The fairness of his judgment in the latter case only serves to lend confidence in his appraisal of conditions at home.

Observe the frankness with which he endeavors to convey his opinion that the trouble with England is that it is "absolutely steeped up to the neck in socialism," of innumerable brands, all having their roots in the broad conception that there is something wrong with private enterprise, private property, wealth and profit, and claiming that we must produce for use and not for profit. As a remedy for this distressful condition he sees the need of a crusade in England on behalf of a true understanding of that system of thrift, work and economy called capitalism, which offers opportunity for individual initiative. Contrasted with this condition in England, the American socialist, in Mr. BENN's eyes, is of a pale, anæmic variety, quite incapable of qualifying for membership in the English Socialist party.

But if Mr. BENN failed to find socialism rampant in this country it did not affect his observation of that outstanding difference between industry in England and America—quantity production by mechanical means.

He sees us devoted also to personal efficiency, which is largely responsible for the fact that we accomplish more per unit of time than do our English friends. He reaches the conclusion that even prohibition is accepted in principle as "a weapon in international industrial competition." In his mind it is "the greatest force to be reckoned with in the world today." Efficiency in industry and in personal matters is seen by Mr. BENN as a fetish of the American people.

There is encouragement for American industry in these views on the part of one who has studied industrial conditions in England and observed them critically in the United States. When we are inclined to think that we have trouble with labor and production, we can find solace in Mr. BENN's conclusion that "America is not heaven, but it is, as I see it, as near to an economic heaven as we mortals shall ever approach."

Readjustment Or Economy?

A FEW months ago all the talk about business affairs generally was that we had entered a period of readjustment. The thought was that the period would be a short one, in which we should simply revise our price lists and things and then business would go ahead much as formerly. The most common remark was that buyers had gone on strike, the idea of a strike of course being that the striker has certain terms and will go to work whenever he gets those terms. The common thought seemed to be that the buyers would win the strike and that would be the end of it. It was all very simple. If a manufacturer could not sell profitably at the prices bid, all he had to do was to reduce his costs. If workmen wanted wages that were too high all that was necessary was for them to be idle a few weeks, or possibly months in the case of the most recalcitrant, and then they would be back at their old jobs, simply working for less money. The bright remark was made that this industrial depression was different from those of the past in that the people knew this time precisely what they were waiting for.

We all know better now. It is much more than a readjustment. It is vastly more than a revision of price lists and wage scales, much more even than a change in men's minds whereby they will kindly become willing to work harder for society, whether in making profits or earning salaries or wages. We have to build up afresh. We must not only become willing to work, we must find a job, or devise means whereby we can render better service.

It is only a few months ago that the main thought was about prices. They would have to come down, and the idea was that as soon as they had come down they would start advancing again. That is not the natural course of affairs. During the war and for a time afterward an "endless chain" was much spoken of, whereby one advance brought on another, and so around a circle. There was an ascending spiral. Can there not be a descending spiral? Dr. RALPH G. HURLIN, statistician of the Russell Sage Foundation, has answered this question, by carrying an index number of commodity prices in the United States back to 1810. This shows that after the war of 1812 there were generally descending prices for about thirty years, then advances culminating in the Civil War, after which there were declining prices for about thirty years, advances then culminating, as we all know, in

1920. One may say that things are different now, but a sapient observer in 1865 might have pooh-poohed the statistics of what followed the war of 1812—that was ancient history! Of course a war does not cause advancing prices for thirty years before it occurs. Quite likely the general or normal trend is upward, but a war sends prices so much above normal that it takes many years for complete return to normal. Dr. HURLIN's figures, by the way, shows the three war peaks to be of practically the same height, and there is no great difference in the two troughs.

It is not a quick readjustment, something to be got through with, but simply years and years ahead of us of hard work, economy and striving for greater and greater efficiency. It is not a case of waiting until the thing is done. The matter of prices is a statistical detail. From about 1896 to 1920 the trend in prices and wages was generally upward. Those who succeeded by reason of that fact will have to adopt a new philosophy. Those who succeeded because they were economical and efficient will not have to change. There will be no success in waiting for prices to come down or in waiting for them to go up. Success will come in reducing costs, and then reducing them more.

Concerning the Threefold State

OUR READERS may recall that in our issue of May 25 we gave the index number of various commodities showing average prices for April of this year as compared with those of 1913 at 100. We recorded farm products as 115, foods 141, clothing 186, building materials 203, housefurnishing goods 274, etc., and it seemed rather hard for the farmer getting 115 for his product to pay 274 to furnish his house.

The fact is and always has been—as a general rule, of course, and subject to modification—that everyone gets as much as he can for his work or his wares. The trouble is that some trades are able to jockey for position while others are not. In our present situation there are occupations which do not call for intelligence above that of a child of twelve or fourteen years, requiring hardly any preparation and involving no personal responsibility, which are better paid than work calling for long years of professional training. Coincident with this we have a great deal of unemployment and not a little suffering from actual want.

Collective bargaining has great merit, and we doubt if employers of labor as a whole are good enough to get along without it. But collective bargaining, as we call it, is a misnomer. It is rather group bargaining, and the separate groups often play havoc with the general welfare. It has also a degrading tendency on skilled labor, for it destroys initiative and sometimes discourages specially good work. By including unskilled labor in certain occupations it has made a hod-carrier a \$10 man, while the draughtsman in the architect's office who is a graduate architect gets \$30 or \$40 a week. We do not begrudge the hod-carrier his \$10 a day, or whatever he gets; we object only to the high price that his less lucky brother must pay for rent in consequence of increased building costs. What we lack is co-ordination in the rewards of labor that would provide for the welfare of all.

All sorts of remedies have been proposed for the former evil which obtained when employers fixed wages and the present one when leaders of separate groups of laborers fix them for those they represent, but the

right way does not seem to have come into function. Now comes a new proposal by Dr. RUDOLPH STEINER, a Hungarian, whose book "The Threefold State" has had a great sale in Continental Europe and in England, but as yet has not got into general circulation here. Dr. STEINER holds that most of society's ills are due to excessive centralization. He describes the contradictory forces at work and proposes to separate the fields of human endeavor into a trinity of departments, viz.: into the Economic, the Political, and the Spiritual State.

The Economic State is concerned with materials, with the most economical production, and the distribution of commodities. It is business; it employs labor, but does not fix wages. Labor is not a commodity, and to confuse the function of men with that of materials leads to trouble every time. We have not his book, but are informed that business may be conducted under such an economic state in a manner similar to that which now obtains except that employers shall have no voice in fixing rates of wages or hours of work. If the cost of labor is too high business will not undertake the venture.

The Political State fixes and adjusts the rates of wages for all crafts and all labor, and the hours of work. This is done by the people's representatives as a whole, and therefore all dispute between employers and employees as to wages and working hours shall come to an end. Then politics will not fix the pay for a few favored ones very high and let the others starve. If carrying a hod is worth \$10 a day and plasterers should get \$15 to \$20 for what they call "bankers' hours" (which are the hours of banks' customers rather than the hours of the bankers themselves), then these rates will rule. If, however, such wages make rents too high, the chances are that politics will bring them down, for there are too many printers, clerks, street railway employees, policemen and miscellaneous people for hod-carriers and plasterers to rule politics. Whatever politics says in regard to labor, goes.

The so-called Spiritual State includes education, the guarding of individual liberty, and is to hold the individual genius free from outside control.

That is the rough outline from a brief review of the proposal that is being widely read and considered in Europe. An industrial company called the Futurum Co., Ltd., with \$1,000,000 capital has been organized to carry on manufacture under Dr. STEINER's plan at Dornach, near Basel, in Switzerland. The proposal has to do with governments rather than with corporations, as we understand it, but the projectors of the Futurum Co. are so certain of the merits of the plan that they believe their methods will become general and accepted by all.

We hope the book will soon become available, for it behooves us to keep posted on the ideas that are spreading. Had more intelligent persons who are familiar with the actual problems of administration made themselves thoroughly familiar with the socialist theories we might have been delivered from much of our present trouble. Many readers have been misled because they lacked the vision that comes from experience, and there has been lacking the quality of criticism that speaks from experience. We are free to confess that the Threefold State looks rather raw at first glance, but for all that it certainly deserves careful and sympathetic study. The present chaotic method of fixing wages by means of strikes and bludgeons is not sound.

Readers' Views and Comments

Heterogeneity in *Canis Variegatus*

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having noted in a recent issue of your English contemporary the *Ironmonger* brief mention of an important research by my friend, Dr. B. Feeter, F.R.S., M.I.V., F.O.O.L., etc., etc., I take the liberty of forwarding you this somewhat more extended account of his remarkable findings, hoping for its hospitable reception in your columns. Dr. Feeter, as is well known, was the Kitcheners Research Scholar for 1901, and Fitts medalist in 1903. His latest investigation into scientific technology is "On the Variations in the Distribution of Currants in Spotted Dog."

Spotted Dog, as it is perhaps unnecessary to point out, is the English urchin's pet name for a goody which to know is to appreciate. However, the question of the rendering in correct scientific language of the term "Spotted Dog" has been a matter of anxious consideration to the editor of the *Ironmonger*. It was finally concluded that the choice lay between *Canis variegatus* and *Canis maculatus*. The objection to *variegatus* was that, though the adjective might pass if the object under examination had been a pink or a peony, a variegated dog, and still more a variegated pudding, were monstrosities, even in Latin. On the other hand, *Canis maculatus* suggested not only a spotted dog, but a blotched or pimply dog, and even, if taken in its ethical sense, an immoral dog. What clinched the matter was the discovery that in the text about the leopard and his spots, spots is given as *varietates*. But anyway, says the editor rudely, one spotted dog-Latin word is as good as another. So his article was entitled "An Investigation of *Canis Variegatus*."

Dr. B. Feeter points out, in the first place, that it has long been recognized that marked irregularities occur in the distribution of currants in spotted dog. For example, Van p'Uff showed in 1907 in the *Archiv für Küchenwissenschaft*, Band CXIX, Heft 497, that in fifty commercial specimens examined by him there was marked segregation toward the center, and when this was excessive was very detrimental to its cohesion and general rigidity. Dr. P. L. Um proved, in *Wirtschaftliche Mitteilungen von Podingswesen*, for Jan. 15, 1908, by taking consecutive sections that currants were entirely absent from the extreme ends. Mr. P. R. Ice, in comment on this work, showed that little objection would be encountered from the purchaser if the currants were deep seated, that is subcutaneous, and not contributing to any surface defect. Mr. Chowder, in the National Quizzical Society's Memoirs for 1909, reviewed all the work of experimenters and propounded the theory that is now associated with his name. Mr. Chowder's hypothesis, as is well known, is based almost wholly on the assumption that the distribution of currants is effected solely by heat-treatment, and he rejects the hitherto accepted theory that it is caused by a lack of homogeneity in the plastic mass.

In order to test the soundness of this theory the author, with the advice and assistance of Prof. Costard, entered upon the research which is here recorded.

It had been suggested that a simple method of procedure would be to watch a number of spotted dogs

during the processes of manufacture, but this plan was rejected as both unscientific and unlikely to require the thousands of observations that are demanded by a modern research. It was felt that the correct course to pursue was as follows:

1. To obtain as large a number of spotted dogs as possible, and here it is proper to record special indebtedness to the co-operating concerns, who in the interest of science, and for the upbuilding of their product to technical excellence, have so generously supplied the specimens.

2. To make a complete analysis of each specimen.

3. To take consecutive sections (a) in a horizontal plane, (b) in a vertical plane, (c) in a plane inclined to the vertical, (d) in a plane inclined to the horizontal, (e) in tangential planes at intervals of five degrees round the circumference, and (f) in a left-handed spiral extended from the apex at one end to the apex at the other.

4. To test the specimens thus secured by tensile, bending, impact and torsion, both in the state as received, after having been fully annealed, and after a quenching. It was recognized by Dr. Feeter that these were not strictly required for the research, which, it may be remembered, was merely to study the distribution of currants in *Canis variegatus*. However, we are more clearly coming to perceive that the normal failures are not giving us the trouble to explain as are the abnormal, and the latter are doubtless due in the last instance to submicroscopic segregation. Consequently, any investigation into segregation has a special application in this direction. Furthermore, it was thought that the results of such a series of tests as in item 4 would furnish a volume of data which would enable a comparison with the results being obtained by the International Joint Co-operative Investigation of the Effect of Sulphophosphates on Meal.

5. To determine the hardness by the Brinell method and by the scleroscope.

6. To examine all specimens by reflected, transmitted, plane polarized light, and to determine, if possible, the number of currants per meter cube by counting the fragments of seeds as seen in an oil immersion microscope.

To carry out this program in its entirety no less than 12,500,764 separate observations had to be made, but the results have fully justified the work involved.

The original manuscript starts out by giving a description of the apparatus employed (which occupies seventy-five pages of his paper and is accompanied by forty-nine drawings and photographs). Then follows a tabulation of the results in 963 tables. It is much easier to appreciate the findings by examining the graphs which are attached to the original manuscript, 742 in all.*

CONCLUSIONS

1. It has been finally proved that dimorphic allotropic forms of dough (α dough and β dough) may exist side by side in a single specimen of the size used in these tests. The exact nature of β dough is unknown; Prof.

*Unfortunately it will be impossible to reproduce even a few of these remarkable diagrams on account of a lack of space.—[Ed.]

Costard holds that it is a true allotrope, although pseudomorph after another modification. B. Feeter, however, contends that it is a transitional form, between alpha and a hypothetical gamma state, which latter are thought to be the stable varieties. Beta is therefore probably a solid solution, or perhaps an allocolloid. Further research is necessary to clear this important point.

2. That undoubted segregation of currants does occur, being greatest toward the center of length and the middle third of the height.†

3. That segregation is irrespective of the nature of the dough, but

4. Is due in some manner that it was impossible wholly to determine to the heat treatment.

5. The determination of the $Ar_{1,2,3}$ points by means of the Le Chantecler pyrometer is rendered extremely difficult by reason of the freezing of the eutectic before the currants have gone into solid solution.

6. Several marked examples of twinning were observed, and the appearance of slip-bands supports Dr. Rosenfield's theory of viscous flow in the intercrystalline amorphous cement.

It should be noted that owing to a misunderstanding on the part of the laboratory boy, who is now suffering from fatty degeneration, the specimens set apart for observations on season-cracking were destroyed. Many instances of fire-cracking have been reported by the manufacturers, and it has been suggested that the Kitchener research fund make a further grant to determine this very practical commercial aspect of the question.

MARTIN SEYT.

Industrial Alcohol and Prohibition

To the Editor of *Chemical & Metallurgical Engineering*

SIR:—The article on "Industrial Alcohol and Prohibition" in the June 22 number of your journal is most illuminating. Dr. Whitaker struck the keynote when he said that the public, to say nothing of the prohibition enforcement agents, need education on the subject of the industrial importance of alcohol.

Words and letters are great teachers, but the greatest of all is experience. Suppose the alcohol producers of the United States refuse to produce or sell alcohol for any purposes whatsoever until the ridiculous enforcement and interpretation of the laws is done away with, and the legitimate use of pure and denatured alcohol is aided and encouraged as expressly provided for by the Volstead act.

Let the overzealous narrow-minded prohibition enthusiast go to the drug store and find that his favorite antiseptic, hair tonic, mouth wash or the simple household remedies such as tincture of iodine or spirits of camphor are either selling at a fancy price or not available at all—and his wife go shopping only to find that perfumes, flavoring extracts, celluloid articles, certain shades of cloth are not in stock. Let them both understand when they ask the reason for this state of affairs that alcohol is necessary for the manufacture of these articles, but that its sale and manufacture have been made so intolerable they have been temporarily abandoned.

Let the public learn by experience, if we cannot convince them any other way, the importance of industrial and medical alcohol. I dare say it would be only

a few weeks before the prohibitionists themselves would rush to make amends or pass legislation requiring the manufacture and sale of alcohol for legitimate purposes, which would accomplish the desired results.

In other words, let the public learn by experience, the quickest and best teacher, and the narrow-minded prohibitionist have his heart's delight—remove alcohol temporarily from the market.

Even if research, college and control laboratories have to close for a few months, the sacrifice will be worth the victory. Science must save her master tool, alcohol. For chemistry to go without alcohol is like trying to run an automobile on three wheels.

Malden, Mass.

EDWARD O. HOLMES, JR.

Recovery of Volatile Solvents by Bregeat Process

To the Editor of *Chemical & Metallurgical Engineering*

SIR:—I have read with interest the article by Messrs. Roulleux and Dort on "Recovery of Volatile Solvents by the Bregeat Process," and must compliment these gentlemen on the interesting data given therein, which will, I am sure, prove of considerable interest and service to many users of solvent recovery systems.

The industrial application of the Bregeat process is, of course, more or less similar to the application of other systems of solvent recovery in its principal points, and I do not wish in any way to decry the methods put forward or the results obtained.

There are only one or two statements in the entire article which I feel, in justice to several other processes available, should be corrected. While I am not personally familiar with the development of the Bregeat process in France prior to 1917, I am quite certain that processes for solvent recovery based on accurate scientific principles were in operation in Great Britain and this country before that time. I am personally familiar with the construction and installation of one plant in Great Britain for the recovery of ether-alcohol mixture from cordite manufacture, with which the Bregeat company had nothing to do whatever. I am also familiar with another installation in Great Britain, in 1915, which made use of a crude cresylic oil for the absorption of ether, alcohol and acetone mixture and, of course, in Great Britain crude creosote oil has been in use for many years for the absorption of benzene from coke-oven gases.

I wish to correct one or two statements in the summary, in which it is stated: "Until the Bregeat process had been developed the solvent recovery was not an industry itself. The Bregeat process is responsible for bringing solvent recovery out of the class of an incidental and casual art into that of an independent and well-established business."

It seems to me that these two statements require considerable modification in justice to both British and American firms which have been building and installing solvent recovery equipment of the highest type for several years. In Great Britain, I mention my own firm of Blair, Campbell & McLean, Ltd., of Glasgow, Scotland, which was probably the first in the field, and in this country Messrs. Badger of Boston, Lummus of Boston and finally, the American offshoot of Blair, Campbell & McLean, Ltd.—namely, the American Chemical & Sugar Machinery Co., which in co-operation with the Lewis Recovery Corporation of Boston has developed the explosion-proof solvent recovery system.

Philadelphia, Pa.

JAMES C. LAWRENCE.

†See Tables 904 to 950 and diagrams 300 to 360 of the original. —[Ed.]

Solvent Extraction in the Vegetable Oil Industry

Principle Involved in the Solvent Extraction of Oil From Vegetable Oleaginous Materials—Commercial Development of the Industry—Stationary and Rotary Types of Extractors—Principal Solvents—Economic Considerations—Uses of Products Obtained*

By J. H. SHRADER, PH. D.

Formerly Chemical Technologist, Bureau of Chemistry

FOR a great many centuries man has obtained vegetable oil from fruit and seed by applying pressure. One of the earliest applications was that simulating the simple mortar and pestle, whereby the operator broke the oil cells by pounding a small lot of the oil-bearing material in a heavy container and collected what oil flowed freely. An early application of power was the grinding mill operated by a bullock. Then were developed powerful edge-runner grinders in which the oleaginous material placed in a rotating pan was ground by vertical grindstones running on their rims. The direct application of static pressure to given lots of oleaginous material was the old wedge press, wherein the charge was bagged or wrapped in some sort of heavy cloth, placed in a frame and subjected to a pressure of many atmospheres by driving heavy wedges between the cake and a head block. Following this, the hydraulic press was developed, whereby the wrapped cakes of oleaginous material were subjected to powerful hydraulic pressure. A more recent development is the hydraulic cage press, whereby two or three times more pressure is applied and a steel basket is substituted for the cloth wrapping of the cake. In the best of these the cake still carries about 4.5 per cent of oil, and more usually about 5.5 to 6 per cent. Many mills cannot produce even as well as this.

In view of the ready solubility of vegetable oil in several volatile solvents and the universal laboratory application of this to the exacting requirements of quantitative analytical procedure, it is to be expected that effort would be made to apply it to industrial operations. This was successfully done about seventy-five years ago.

The principle involved embraces grinding the oleaginous material to such a degree that the oil cells are broken as much as practicable, and then treating the mass with an excess of some volatile solvent such as gasoline or benzene, drawing off the oil solution from the extracted residue (or pomace, as it is called), and distilling the solvent from the oil. The solvent is returned to storage and used for subsequent extraction. The process sounds simple, and so it is theoretically, but as an industrial operation it is somewhat involved and requires a high degree of technical attention to be a successful commercial enterprise.

COMMERCIAL DEVELOPMENT

The advantages and simplicity of the solvent extraction of oils early led to its application to the olive-crushing industry. The residues left after expressing as much oil as possible are treated usually with carbon bisulphide; hence the trade name, sulphur oil. This oil is of low grade, caused not only by the solvent used—

namely, carbon bisulphide—but also due to the residues having been previously pressed, macerated with water, heated and again pressed, often several times previously to extraction with solvent. Such technical mistreatment probably accounts in a large measure for much unfavorable criticism of extracted oil.

Before the war a large industry grew up in Germany based on the extraction of oil-seed cake which contained a particularly high percentage of oil. The inefficient crushing performance of tropical native and even more or less modern mills was the basis for this thriving industry and high-oil cake was shipped all the way from the Philippines to Hamburg. German firms were growing rich on what others wasted. Usually gasoline or one of the chlorinated hydrocarbons was the solvent. Both the oil and the meal were successfully marketed, although at a discount because of the quality produced.

For years the solvent extraction of oils has been practiced in England on a large scale. This has been quite successful, as is manifest from the favorable criticism appearing in the literature.¹ Extracted oil of high grade is now made for edible purposes, particularly for use in the margarine industry, but opinion differs as to the uniformly satisfactory character of the finished oil. This extracted oil is refined and deodorized following practices similar to those applied to hydraulically produced oil. A recently equipped mill has a capacity of 1,200 tons of raw material per week. Some mills produce their entire tonnage of oil by solvent extraction, without applying a preliminary hydraulic pressing to the oil-bearing material.

It is common knowledge that in Manchuria a soybean solvent extraction plant was installed several years ago and is apparently being operated satisfactorily. Several more such plants are now being introduced into Japan.

In the United States the use of solvent extraction has not been an unqualified success. Four concerns applied it to extracting linseed oil from flaxseed, using gasoline and the stationary percolator type of extraction machinery. One plant after another was discontinued until at the present time none of these plants is extracting by solvent. Much trouble was experienced in marketing the meal due to the difficulty of removing therefrom the residual traces of solvent. This unsatisfactory performance has become so widely known that today it is presented as irrefutable evidence of the futility of the method, notwithstanding the fact that modern practice has greatly improved the procedure by using improved equipment and better solvent. Only in the manufacture of castor oil and recovery of low-

*Prepared in connection with work done in the Office of Drug, Poisonous and Oil Plant Investigations, Bureau of Plant Industry.

¹Oil and Color Trades Jour., Dec. 13, 1919, p. 2281; Margarine and Allied Trades Jour., vol. 1, p. 382 (January, 1920).

grade industrial greases and fats does solvent extraction play a necessary and generally recognized part.

At the present time several extraction plants in this country are operating apparently satisfactorily on various vegetable oil-bearing materials. They are extracting coconut oil cake and parings, cottonseed, cottonseed cake, corn germs cake, castor beans, palm kernels, pine-tree wastes and other miscellaneous oleaginous materials. One plant here is said to be making a solvent extracted oil of edible grade for cooking purposes after refining and deodorizing it. Then, in addition to these,

This finds its greatest application in treating garbage and slaughter-house wastes. Several such plants are in active operation in the United States.² Since, however, this is a special line, it is not discussed here.

TYPES OF EQUIPMENT

The machinery used in the solvent extraction of vegetable oil and other fat-bearing material consists of two general classes—namely, stationary and rotary. In the former the extraction unit is essentially a stationary tank, usually with its longer axis vertical, and

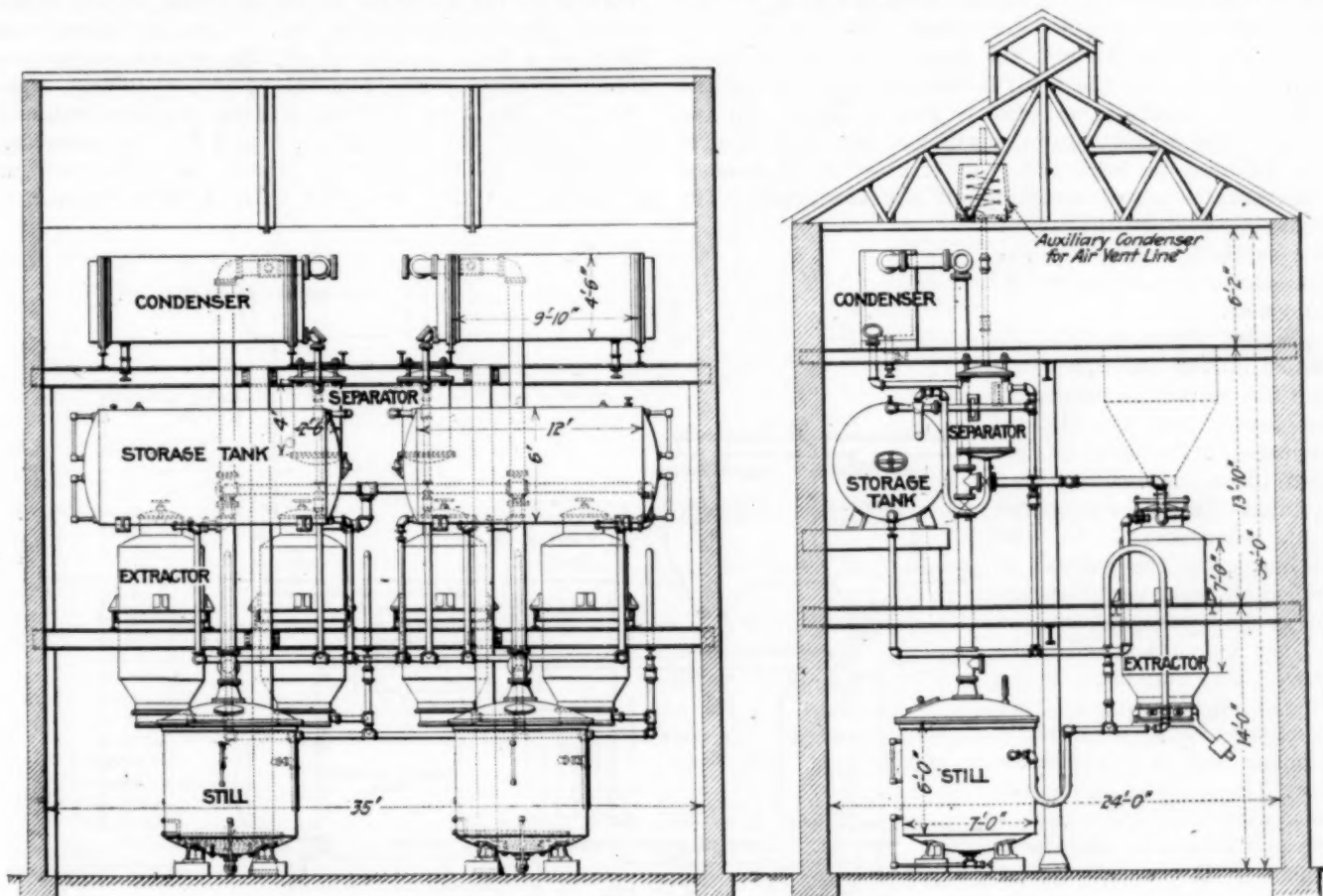


FIG. 1. SECTION OF EXTRACTION PLANT OF GERMAN TYPE

several plants are engaged in extracting the residual fat from bones and other animal wastes.

Thus this industry is fairly well developed. It has a foothold in the leading countries engaged in producing oil and is not only holding its own but is growing. Although originally developed for treating materials producing inedible oils and fertilizer, it has been so improved that now it is being increasingly applied to the production of oil and meal of edible grades. Among the materials treated by this process have been:

Palm kernels	Olive residues
Coconuts (fresh)	Rice bran
Copra	Fish residues
Rapeseed	Fullers earth
Soya beans	Pine chips and stumps
Linseed	Shay nuts
Castor beans	Mowrah nuts
Corn germs	Meat scraps
Cottonseed	Bones
Wheat germs	Garbage

Another phase of solvent extraction has been developed departing in some respects from the procedure as above described—namely, treating a wet oleaginous mass with solvent whereby the oil or fat is removed.

equipped with an agitator of some sort. The rotary extractor, on the other hand, is usually a tank shaped like a boiler and mounted to rotate on its horizontal axis, thus avoiding the necessity of an agitator.

STATIONARY EXTRACTORS

In Figs. 1, 2 and 3 are illustrated different types of stationary extractors. In Fig. 1 the system is more like the German development, in which continuous extraction with fresh solvent received special attention, according to the well-known Soxhlet principle. The solvent-oil solution in the still is kept boiling; the pure solvent vapor rises through the vapor pipe and is conducted into the extractor from above, slowly percolates through it and flows back into the recovery tank with oil in solution. Thus the oleaginous material to be extracted is becoming weaker and weaker in oil; the solution in the receiving tank is becoming stronger and stronger in oil. It is stated that this type is not suitable to the installation of large units, batches of one ton presenting the optimum working conditions. Such

²U. S. Pat. 1,267,611, May 28, 1918; *Chem. Ind.*, vol. 37, No. 17, p. 519-A. Sept. 16, 1918.

small charges may seem uneconomical, but on the other hand it is urged that a small batch can be more easily controlled, with consequent improvement in performance and quality of product.

In Fig. 2 the units are larger and represent the British type of equipment. The extractor unit may be 8 ft. in diameter and 12 ft. high. An iron plate perforated with $\frac{1}{2}$ -in. holes is placed over steam coils to form a false bottom. Over this is laid a plate with smaller holes, and again over this is placed a screen covered with a coarse textile. Such an arrangement keeps the charge of extractive material from falling into and clogging up the draw-off pipe. A stirring arm may be provided in the form of a curved sweep which rotates on the central vertical axis. Since the sill of the discharging door is almost flush with the floor of the extractor, the rotation of the stirring arm can be used to force out the extracted residue when the extraction and steaming off are concluded. The charging door on the top of the extractor allows loading from an overhead hopper or conveyor.

Fig. 3 shows a type in which during the first cycle the hot solvent is saturated as nearly as possible by repeated percolation of the oleaginous material, but without being evaporated and recondensed. In the second cycle the solvent is boiled off from the extracted oil in the lower compartment of the extraction cell, condensed and run back to the extraction cell, where it accumulates and periodically siphons back to the still below. This is in strict accordance with the Soxhlet principle and results in repeatedly washing the nearly spent material with clean solvent. The periodical siphoning is controlled by a float in the lower compartment containing the solvent. In the third cycle the extract accumulated in the still is concentrated by evaporating off the excess of solvent. The condensed solvent is conducted to the storage tank for repeated use. In the fourth cycle both spent meal and oil extract are freed from solvent by steam.

Plants recovering grease from garbage operate on the extraction principle. Several processes are being used for this purpose, but since this is a field in itself, no detailed consideration is given it here. The problem presents itself as one dealing with a low grease content (3 to 5 per cent) and a large amount of water (about 85 to 90 per cent).

ROTARY EXTRACTORS

A more recent type of extractor has been developed along somewhat different lines. This so-called rotary extractor consists essentially of a horizontal, boiler-shaped tank designed to rotate and provided with charging and discharging manholes. A false head or false

bottom allows the solvent with its content of oil to drain away from the oleaginous charge when the percolator is at rest and to be freely pumped out.

Figs. 4 to 6 illustrate several types of rotary extractors. The plant illustrated in Fig. 4 will handle about twenty-five tons per twenty-four hours. The extractors in Figs. 5 and 6 have free chambers placed above or below, or both, corresponding to a false top and false bottom; if one becomes clogged during the drainage of the solution, the extractor is rotated 180 deg. to use the fresh surface. It is evident that the rotating of the extractor serves to break up any tendency to lumping, channeling, etc. When the solvent has taken up a large amount of oil, the rotation is discontinued to allow ready removal of the oil-solvent solution. In the type wherein a free chamber extends the length of the unit (Figs. 5 and 6), the extractor is stopped in the position where the false bottom is below; in that provided with a false head any

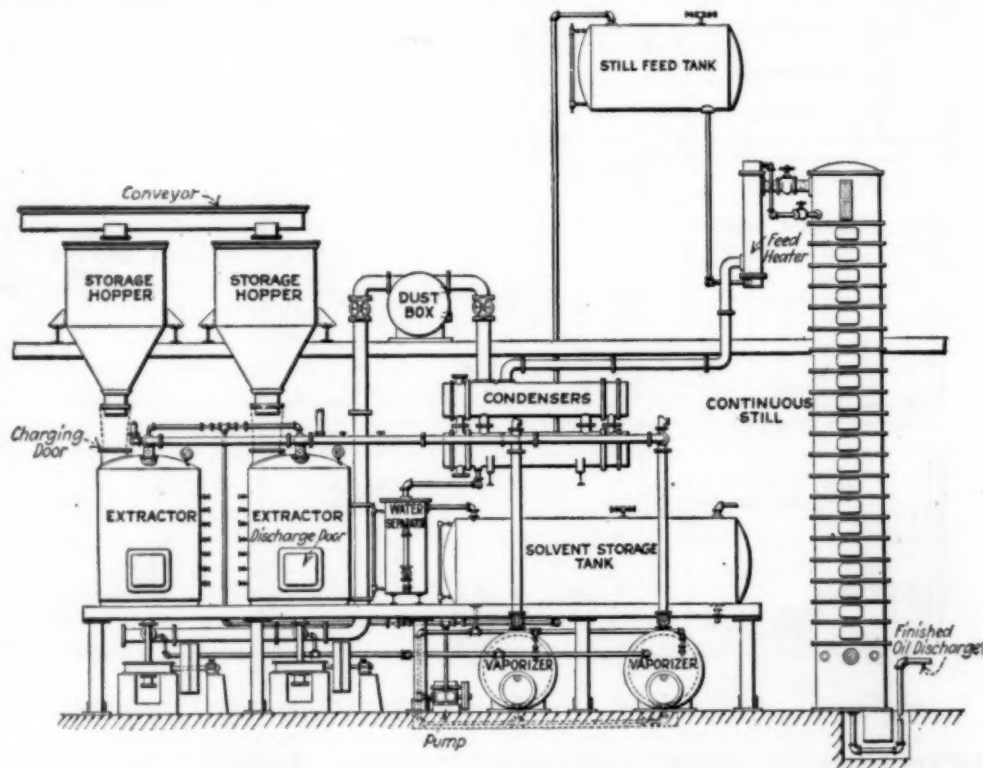


FIG. 2. SECTION OF STATIONARY PLANT OF BRITISH TYPE

position, when at rest, is satisfactory. The solvent-oil solution then slowly drains into the free space within the compartment, whence it is pumped out. A fresh lot of solvent (or preferably one used as a wash in a previous batch) is then pumped into the extractor, and the whole operation is repeated several times until the extraction reaches the point of economic equilibrium—i.e., until there remains so little oil in the charge that its removal is not profitable. In well-operated plants less than 1 per cent of oil is lost in the extracted residue.

Likewise in the process of solvent removal from the extracted oil-free residue (pomace), rotation serves to keep the mass from packing and from allowing the steam to blow through open channels and other free paths of travel.

When the process is complete, the manhole covers are removed and the machine is rotated. At every rotation a large part of the extracted and dried residue

is discharged onto a belt or hopper under the extractor and conveyed to the pomace storage house. The machine is emptied in a few minutes and is then ready for a new charge.

SOLVENTS

One of the most vital factors contributing to the success or failure of the solvent extraction process is that of the kind of solvent used. The issue is not joined so much to the relation between its chemical constitution and the quality of the oil extracted therewith as it is to what might be called the physical or certainly secondary chemical effects. Since these are more or less specific to the several solvents discussed, they will be considered under the respective solvents.

As stated above, carbon bisulphide was the first to be used on a large scale and is even now employed for treating olive residues of low oil content. Such so-called sulphur oil immediately raises in the mind of the trader and user a corroboration of the current discount borne by extracted oil. The technological abuse given the olive pomace before extraction, the more or less faulty equipment and the unsatisfactory solvent are

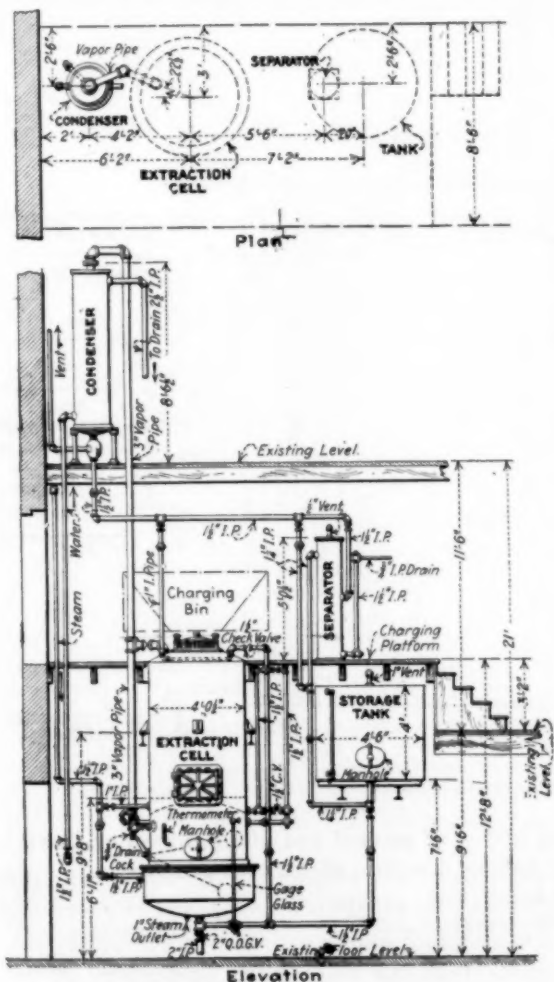


FIG. 3. SECTION OF STATIONARY EXTRACTION PLANT

overlooked. Experience shows that substances containing sulphur more or less loosely combined are exceedingly difficult to remove from products treated with them.

Another widely used solvent in the same category but not quite so difficult to handle is solvent naphtha or gasoline. As is well known, this product is not a single chemical compound with constant properties, but

is a mixture of products with ascending boiling points, varying often from 80 deg. C. (176 deg. F.) to 170 deg. C. (338 deg. F.). When distillation of the solvent from the oil is attempted, the lighter fractions go over first in preponderating amounts. As these are more and more removed, the residual solvent becomes richer and richer in the higher boiling constituents. The result is that the last traces of solvent, which at best would be more or less difficult to remove (as is commonly experienced in removing even ether in laboratory

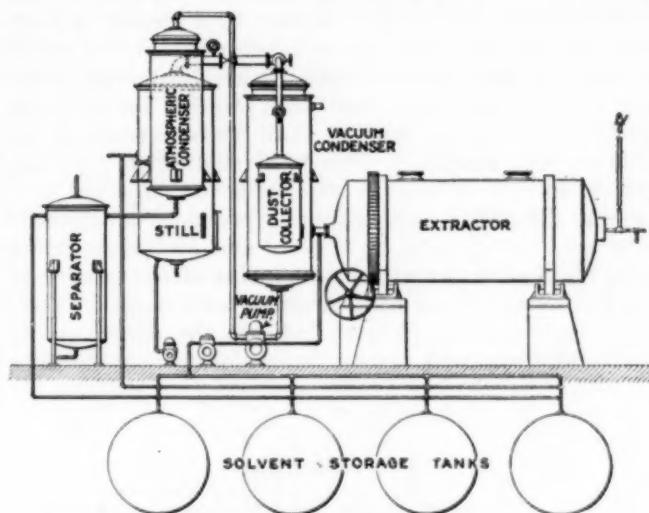


FIG. 4. SECTION OF ROTARY EXTRACTION PLANT

analyses), are rendered increasingly so on account of the residual fractions of unusually high boiling point. It has been pointed out that the losses of solvent accompanying such extraction are greater in the low-boiling fractions with the result that the whole body of solvent gradually becomes richer in high-boiling constituents, thus raising the average boiling temperature. This is corrected by adding some special low-boiling fractions from time to time. The factors favoring the use of this substance are cheapness and availability.

One of the war-time benefits to industry is the greatly increased production of benzene. It is now sold at prices comparable to gasoline and is produced in such quantity that its availability seems to be assured. It comes on the market in several grades designated by the color and the percentage which distills over at 100 deg. C. The residue consists of mixtures of higher boiling constituents. Consequently, use of such a solvent introduces the difficulties experienced in using gasoline—namely, temperature range of distillation and difficulty of removing last traces of the higher boiling fractions. It seems from theoretical considerations, laboratory tests and factory operations that 100 per cent water-white benzene gives the best general results in so far as the common commercial solvents are concerned. At the present time its use in this country in the extraction of the higher grade vegetable oils is probably greater than that of any other solvent.

NON-FLAMMABLE SOLVENTS

All of these solvents, however, possess great flammability. Carbon bisulphide is declared to be spontaneously combustible under certain conditions. To this must be added a toxic effect on the workmen. The flammability of gasoline and benzene is well known. Accordingly efforts have been made to introduce a

solvent free from fire risk. The so-called chlorine-substituted hydrocarbons have been found to answer this purpose. Essentially, they are single chemical products consisting of one or more atoms of chlorine substituted for as many of hydrogen in certain organic compounds. Specifically, the more common ones are bichlorethylene, trichlorethylene, tetrachlorethane, pentachlorethane and carbon tetrachloride. All of these are non-flammable and can be made practically constant in boiling point. The last one is a product of widespread general industrial use. Demand has placed some of the others also on the market to a limited extent. It is claimed that these solvents produce a higher grade of crude oil than do ethyl ether, carbon bisulphide, gasoline and benzene, and that such crudes refine to an edible grade more readily than those produced by benzene and gasoline. This is attributed to their selective solvent action in dissolving out the oil and leaving the other accompanying products unaffected.⁸ However, recent work by Sievers and McIntyre⁹ shows quite plainly that from the standpoint of the quality of finished extracted oil in laboratory tests made in glass flasks there are no facts to indicate the advantage of trichlorethylene and carbon tetrachloride over benzene

tion, protection can be secured by lining the equipment with lead.¹⁰ Probably better practice is to adopt the method patented by Barstow,¹¹ whereby the solvent is passed over a layer of unslaked lime to remove in each cycle the hydrochloric acid formed during steaming. Just how much solvent decomposition takes place is brought out in the following experimental results.⁸ The

TABLE I. PRINCIPAL SOLVENTS WITH THEIR RESPECTIVE PROPERTIES

	Carbon Bisulphide	Extraction Naphtha	Carbon Tetrachloride	Trichlorethylene, $C_2H_3Cl_3$	Ethylchloride, C_2H_5Cl	Benzene
Density...	1.27	0.75	1.632	1.460	1.281	0.884
Boiling point	46°	108°-112°C average	78°C.	87.5°C.	64.9°C.	80.4°C.
Action on metal...	nil	nil	rapid on iron	slight	.....	.....
Specific heat	0.1596 (86-190°)	.50	.131	.....	0.319 (60°C.)	0.436
Latent heat of vaporization...	100.5 (100°) 90.0 (0°)	130	46.4 (76.2°) 82.6 (0°)	.....	85.4 (0°)	100.0 (0°)

figures represent the amount of hydrochloric acid liberated and found either free or combined in solution at the end of forty-eight hours' boiling of a mixture con-

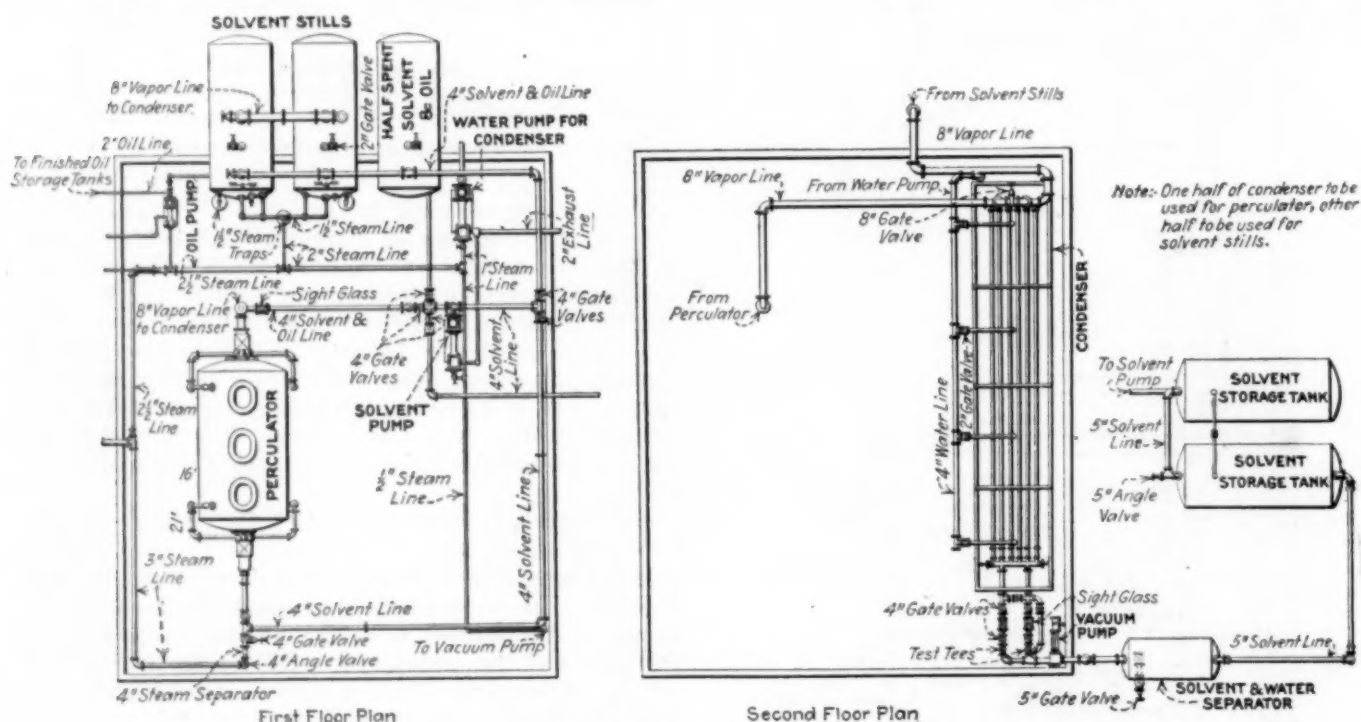


FIG. 5. PLAN OF ROTARY EXTRACTION PLANT

or gasoline, in so far as quality of finished oil is concerned.

Although these properties of non-flammability make the solvents appear ideal, it is also stated that they decompose during the cycle of extracting and steaming with the liberation of free hydrochloric acid. This attacks the equipment and necessitates the use of lead lining throughout. In reply to this it is stated that carbon tetrachloride is the greatest offender and that if trichlorethylene is kept free from the bichloro-derivatives it is perfectly safe from dissociation.⁸ Even if solvents are used which undergo this slow decomposi-

taining 250 g. of solvent and 100 g. of water in an iron vessel having 2 sq.dm. of exposed surface.

Bichlorethylene, grams.....	0.01
Trichlorethylene, grams.....	0.007
Perchlorethylene, grams.....	0.036

It seems that the chlorinated substances do attack the containing equipment, necessitating a relatively expensive lining with lead. Table I gives a list of the principal solvents with their respective properties.⁸

The speed of evaporation of various solvents is frequently of special interest. Table II¹² shows the com-

⁸Oil and Color Trades Jour., vol. 36, p. 2109.

¹¹Les Matieres Grasses, No. 102, Oct. 15, 1916, p. 4612.

¹²Oil and Color Trades Jour., vol. 36, p. 2109.

¹³This table was prepared from data in standard compendia.

¹⁴Booklet of The Barrett Co., issued September 1, 1919.

⁹Oil and Color Trades Jour., vol. 42, p. 549 (1912).

¹⁰Cotton Oil Press, February, 1921.

¹¹Oil and Color Trades Jour., Jan. 20, 1920, p. 334.

TABLE II. SPEED OF EVAPORATION OF PRINCIPAL SOLVENTS

	Minutes
Ether.....	2
Carbon bisulphide.....	5
Gasoline, 70-72° Bé.....	10
Carbon tetrachloride.....	11.5
Pure benzene.....	12.5
Straw color benzene.....	26
Motor benzene.....	27
Straw color toluene.....	35
Pure toluene.....	38
Pure xylene.....	120
Motor gasoline 58-60° Bé.....	155

parative speed of evaporation of the most commonly used solvents. In each case 5 c.c. of each material was allowed to evaporate under similar conditions from an alberene stone dish approximately 4 in. in diameter. The materials tested, other than coal-tar products, were purchased in the open market and therefore represent commercial grades.

The financial advantage of using a solvent with a fairly constant boiling point over one which has a wide

which is non-flammable, will distill off at the lowest practicable temperature, require the least coal, produce the best grade of oil, be cheap, stable and commercially available. No one solvent fulfills all of these requirements. At the present time, practice seems to favor benzene.

ECONOMIC CONSIDERATIONS

It is at once apparent that if the process is at all practicable it points to great economic advantage. The most evident advantage of solvent extraction over pressure is in the matter of yield of oil. When an ordinary hydraulic box press produces cake with 6 per cent oil, it is considered good performance. The average in the cottonseed oil industry for the 1919 season was about 6.4 per cent, as is evident from the analytical reports constantly presented in the cottonseed oil press. The introduction of the cake or curb press is stated to improve on this to some extent, since they are said to

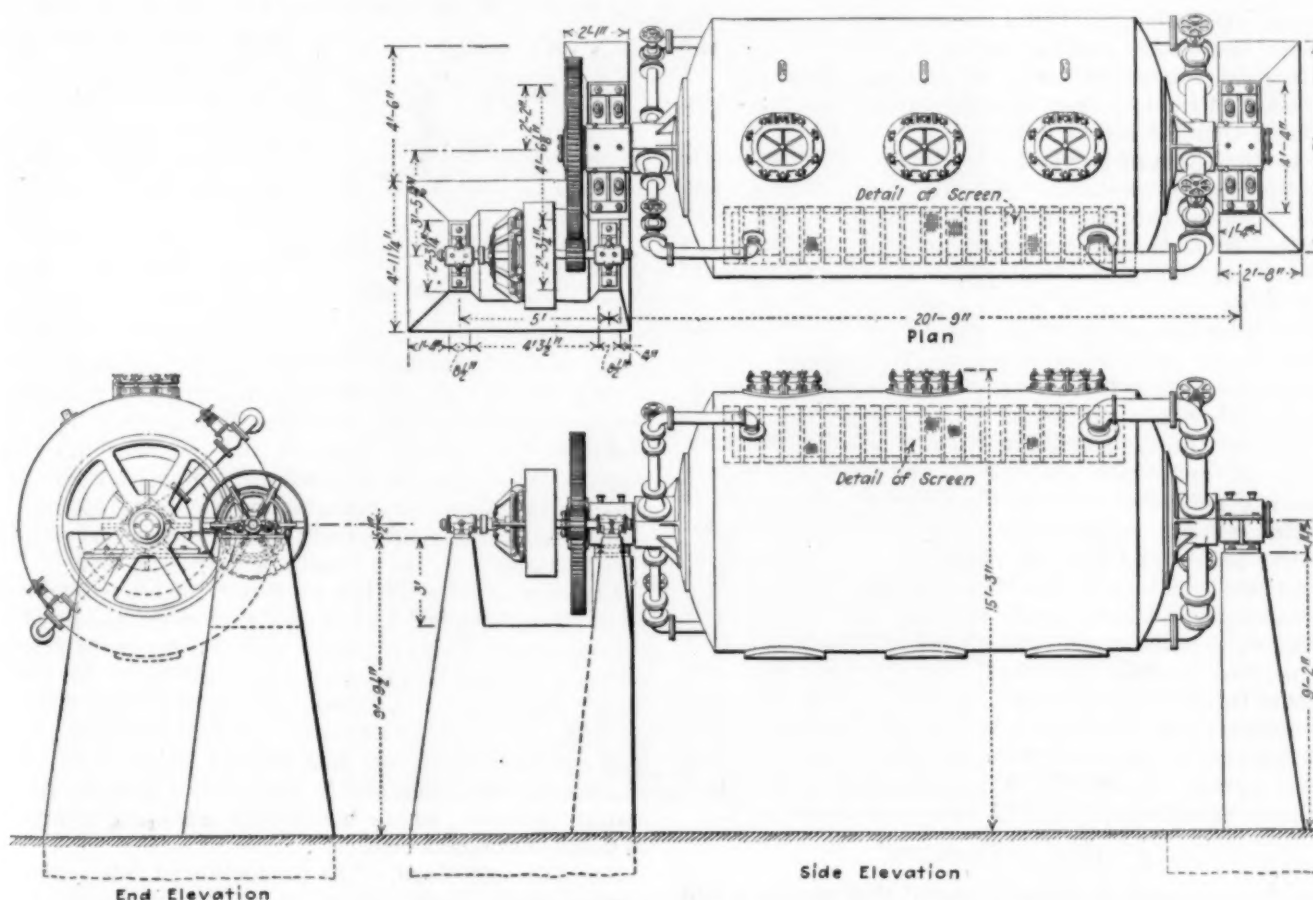


FIG. 6. PLAN AND ELEVATION OF ROTARY EXTRACTOR

temperature range of distillation is brought out by the statement of an operator who has used both gasoline and benzene that about 3,000 lb. of steam per ton of garbage treated would be required to distill off 72 deg. Bé. gasoline, leaving about 2½ gal. in the residue (hence lost), while benzene would require about 2,200 to 2,300 lb. of steam, leaving only about 1 gal. unrecovered. It is to be noted that this estimate is checked by the fact that in the proportions of the heats of vaporization of gasoline and benzene—namely, 130 and 100—there would be required 2,308 lb. of steam for the benzene distillation, assuming that 3,000 lb. of steam were required for the gasoline.

It will be recognized that the best solvent is one

have produced cake as low in oil as 4 per cent. However, this is admittedly uncommon practice. About 6.4 per cent oil in cake can be accepted as representing average practice in the oil industry where hydraulic pressure is used.

To produce a meal by solvent extraction containing 2 per cent oil presents no difficulty whatever. Manufacturers of this type of machinery guarantee meal to contain no more than 1½ per cent oil. It is to be expected that 1 per cent oil-bearing meal is perfectly feasible. From such a non-fibrous, mushy product as castor beans, a pomace can be produced which will average as low as 0.6 per cent of oil.

Table III gives the oil yields by the pressure method

TABLE III. OIL YIELDS BY PRESSURE AND EXTRACTION METHODS

Oilseed	Oil Content Per Cent	Percentage of Total Oil				
		Yield of Oil— Pressure Per Cent	Extraction Per Cent	Pressure Per Cent	Extraction Per Cent	Difference Per Cent
Peanut.....	46-50	42	47	86	98	12
Cottonseed.....	23-25	17	23	67	97	30
Copra.....	64-66	61	64.5	94	99	5
Hedge mustard seed.....	24-26	17	24	68	96	28
Hempseed.....	30-35	25	32	76	97	21
Kapok.....	24-26	17	24	68	96	28
Flaxseed, European.....	34-36	28	34	75	97	22
Flaxseed, East Indian.....	39-42	33	41	81	98	17
Corn germs (dry process).....	17-22	12	19	60	94	34
Corn germs (wet process).....	40-50	40	44	89	98	9
Poppy seed.....	48-50	42	48	84	98	14
Mowrah.....	50-52	46	50	89	98	9
Palm kernels.....	48-52	44	49	88	98	10
Rape seed.....	39-42	33	41	82	98	16
Castor beans.....	45-55	45	51	90	98	8
Sheanuts.....	46-48	41	46	87	98	11
Soya beans.....	17-19	10	17	55	93	38
Sunflower seed.....	29-34	23	30.5	74	97	23

The last column gives some idea of the oil economy in solvent extraction.

Note: It is to be noted that the yield of oil cannot be found by subtracting the oil content of cake from that of the seeds, because oil in cake is figured on the basis of cake and not on the original seed.

versus extraction, with the corresponding loss of oil. These figures are recalculated from Merz' table;¹¹ the extraction figures are based on leaving 1½ per cent oil in cake. Fractions less than 0.5 are discarded; those greater than 0.5 are as units.

Another item of particular importance at this time is that of cost of operation. A force of one foreman and two laborers can operate a 50- to 100-ton percolator plant. In fact it is estimated that an overall charge of \$11 per ton of raw material will cover all costs of producing crude oil by solvent extraction in a 50-ton plant, while about \$7.50 per ton of raw material will cover those in a 100-ton plant. In addition to the monetary saving, there is the added advantage of reducing labor to a minimum.

Against these advantages are fire risk, lower grade crude oil and trade prejudice. The first seems prohibitive, but when one considers the great number of pharmaceutical houses, paint and varnish works, explosive plants and last but not least every automobile, regarding which there is no hysteria, the objection pales considerably. A lower grade of crude oil is undoubtedly obtained in some cases (though not necessarily in view of certain recently published work of J. H. Shrader, *Cotton Oil Press*, April, 1921, p. 42). Trade prejudice is indeed to be considered, but is not insurmountable, particularly if the plant procedure is such as to produce a high-grade refined oil. After all, trade prejudice is built on experience; it can be destroyed accordingly.

USES OF PRODUCTS

It is often and persistently stated that products (oil and meal) obtained by solvent extraction are not comparable with those yielded by expression. Such statements are only partly correct. There is no doubt that solvent extraction has produced oil and meal of low grade, evidenced by high color and traces of solvent. But it is also true that extracted products have been produced free from such objection. The operator of the extraction plant of a large linseed oil company stated that in the years of his service he never received a single complaint of solvent in his meal. It is moreover true that extracted oils may be darker in color than expressed oils, but these can often be refined to comparable grades indistinguishable from expressed standards.

Heretofore the chief rôle of the solvent extraction

plant in the vegetable oil industry has been to work up off-grade residues, damaged seed, leather scraps and other materials of little or no other value than their fat content. Not much attention seems to have been devoted to giving the products any other outlet than what they can readily find in competition with other admitted low-grade commodities. The oils go to industrial uses (paint, soap, etc.); the meal mostly goes to fertilizer. In Europe, however, these extraction products are used for human food. In this country the meal is beginning to find a market as stock feed. If history repeats itself (we seem almost always to follow European practice) we shall follow Europe in finding ways to prepare even the oil for food.

Classification of Lead Production

Sub-committee I of the Society for Testing Materials' committee on non-ferrous metals and alloys reports as follows on the available supply of pig lead:

For the ten years ended Dec. 31, 1920, the production of pig lead in the United States from foreign and domestic ores averaged 559,000 tons per annum. This production can be divided into the following classes:

DOMESTIC		Tons
Desilverized (corroding and common desilverized).....		273,000
Southeast Missouri (chemical lead).....		176,000
Southwest Missouri (soft Missouri lead).....		33,000
Antimonial lead (not covered by these specifications).....		16,000
Total.....		498,000
FOREIGN		
Desilverized.....		58,000
Antimonial.....		3,000
Total.....		61,000
Grand total.....		559,000

Corroding Lead.—The greatest use for pig lead in the United States is for the manufacture of paint pigments. As the production of low-bismuth corroding lead is insufficient to fill this demand and as there are consumers who prefer low-bismuth corroding lead for purposes other than the manufacture of paint pigments, corrodors to obtain the benefit of a broad market should take quotations on both grades of corroding lead.

Chemical Lead.—Of the southeast Missouri lead ore from which chemical lead is produced about one-third is refined by the Parkes process and thereby made into a high-grade low-bismuth corroding lead 99.99 per cent pure. More than 100,000 tons of chemical lead is used annually by the manufacturers of acid-resisting sheet lead, storage batteries, lead-encased cable, lead pipe traps and bends, etc., and in the Central Freight Association territory, where the freight rates are favorable to users of common lead.

Soft Missouri Lead.—The production of this grade is comparatively small, and its use is largely confined to the St. Louis and Chicago districts.

Desilverized Lead.—As all grades of lead are desilverized with the exception of chemical and soft Missouri lead, this class would cover all other grades of lead not pure enough to be sold under corroding specifications.

Chemical specifications for pig lead in the tentative standards now specify for both low-bismuth and high-bismuth corroding lead, as follows:

Element	Low-Bismuth Corroding Lead Per Cent Not Over	High-Bismuth Corroding Lead Per Cent Not Over
Bismuth.....	0.0050	0.0500
Silver.....	0.0015	0.0010
Copper.....	0.0015	0.0010
Copper and silver together.....	0.0025	0.0015
Arsenic.....	0.0015	0.0015
Antimony and tin together.....	0.0095	0.0060
Zinc.....	0.0015	0.0015
Iron.....	0.0020	0.0020
Lead (by difference).....	99.9780	99.9375

¹¹Merz. *Chem. Trade Jour.*, vol. 53, p. 97.

Frederick Fraley Sharpless, Secretary, A.I.M.E.

IF THERE is anything in name and antecedents the directors of the Institute did well in selecting Frederick Fraley Sharpless to succeed Bradley Stoughton as secretary of the American Institute of Mining and Metallurgical Engineers.

Born in West Chester, Pa., of good old Quaker stock, his early days were spent on the farm on the Brandywine, in the center of Revolutionary battlefields. The companionship of his father, an able mineralogist, the gathering of a collection of his own of no mean proportions from the inexhaustible riches of Chester County and the enthusiasm of an Ann Arbor graduate serving as an instructor of sciences in the normal school of his native town filled young Sharpless with a desire to study chemistry.

Columbia and Tech. were beyond his means, but the generosity of Michigan rendered possible the study of chemistry at Ann Arbor. Studying under such men as Prescott, Cheever, Pettee, and Alexander Winchell, and a summer with Theodore Robinson and F. A. Emmerton at Joliet, it was no wonder that the students of chemistry absorbed some of the enthusiasm of these men, and the belief that chemistry would eventually be regarded as an indispensable asset to metallurgy, geology, mining—in fact many and diverse branches of industry.

Upon graduation (1888) Mr. Sharpless went with the late Dr. M. E. Wadsworth to Houghton as instructor and later became professor of metallurgy, ore dressing and assaying. The students of those days—our associates of today—have not forgotten his lessons in stoichiometry and furnace reactions, which modern chemists tell us were all wrong in spite of the way the equations balanced and the metal ran out of the tap hole.

Mr. Sharpless became a member of the Institute in the year 1889, and was one of the members visiting Europe as the guests of European mining engineers that year. Referring to the records of the Plattsburg meeting of the Institute in 1892, as recorded in the *Transactions*, it will be noted that Mr. Sharpless was married in June of that year, and that a reception for him and his bride was one of the features of the meeting. Dr. Raymond, making the presentation speech, gave him some sound advice, which possibly is responsible for his good standing with the members of the Auxiliary. The lines the doctor spoke in handing some silver spoons to the bride were:

Take then these trifles, may they teach a golden truth
in silver speech;
That as the years of wedlock run, the days of spooning
are not done.

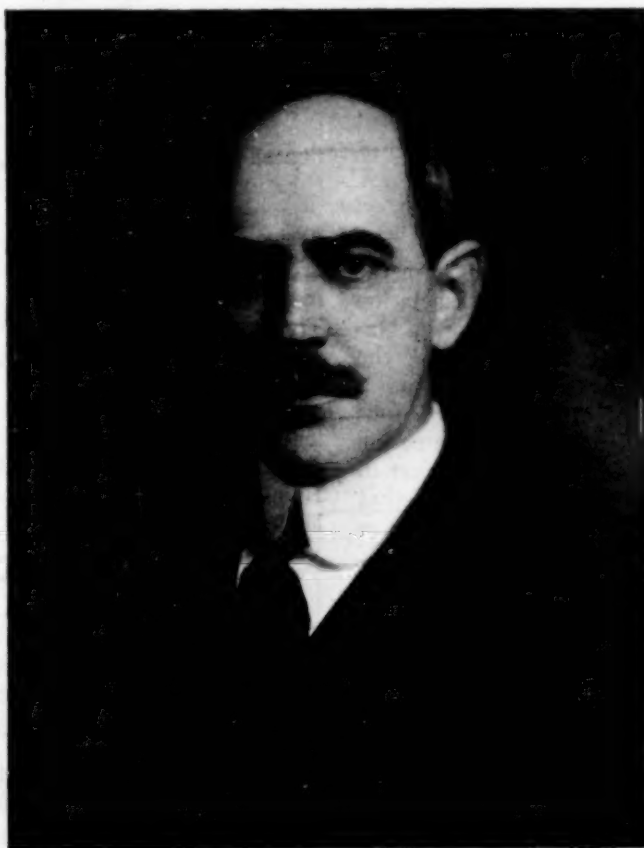
Leaving Houghton in 1892, he opened a chemical laboratory in Minneapolis in association with H. V. Winchell. Winchell gathered the samples, Sharpless made the analyses and assays, but it was not long before questions in regard to mine and mill operating began to come thick and fast. Since the business had developed in an unanticipated direction it was evident that a part of his education had been neglected. He therefore proceeded to remove the deficiency and become acquainted with operating details in the mine and smelter. The laboratory was closed and Sharpless went to work as a miner and mill hand on the Mother Lode, where Richard A. Parker and W. L. Honnold were

conducting extensive exploration work. Two or three years' strenuous work from Coulterville to Angels Camp gave him the experience that he had previously lacked. From this College of Hard Knocks he graduated to accept the management of the California Copper Co. A furnace at Madera was operated until it had smelted all the ore in its own mine, and all that it could beg, borrow, buy or steal from its neighbors.

From 1900 to 1912 Sharpless was a wanderer, traveling, reporting, exploring and operating for English principals, chiefly as American representative of the Consolidated Mines Selection Co. of London and its affiliated organizations. This work took him to British Columbia, the Yukon, Alaska, to many parts of Mexico, into Salvador, Honduras, and South America, where his mining experience was interesting and profitable and

where his political experience rivaled that of Richard Harding Davis. Two years in Colombia familiarized him with mining possibilities of that country, and was followed by the investment of considerable English capital in substantial mining ventures. Only one who has lived the life can know much of the continued interest in new scenes, the examination of operating and abandoned mines, near mines and prospects.

A season was spent in Asia Minor, where the mercury resources were investigated, two properties were bought, equipped with Scott furnaces and placed on a producing basis. One of them was a pronounced success, and during the World War the Turks found it quite serviceable. Another season was spent in the bush on the West Coast of Africa, in mining examination and in fighting malaria, yellow fever and various other microbes which make life interesting if not enjoyable in that country. Sandwiched into these in-



FREDERICK FRALEY SHARPLESS

Photo by Pach

vestigations was a trip to Dawson. It occurred in the spring preceding the visit of Beatty and Perry, and Sharpless spent a month looking over the field with the idea that many of the frozen placers could be worked by modern dredges—thus having the same thing in mind which they later took up. While Sharpless was of the opinion that such a venture would eventually prove profitable, he advised against tying up for a long time the immense amount of money involved, pending the acquisition of reasonably accurate data on the returns which would be secured.

For the past eight years Mr. Sharpless has had an office in New York where he has been employed in consulting work, visiting many of the mining districts through the United States, Mexico and Canada for American clients. For three years he was secretary of the Mining and Metallurgical Society of America, and at all times he has given freely of his time to that class of the engineer's work which brings no emoluments except the satisfaction of knowing that one has done a work that was worth the doing.

Note on Alloying Tellurium With Some White Metals

BY J. H. RANSOM AND C. O. THIEME

IN A mimeographed article recently received from the Solder and Bearing Metal Manufacturers Association the secretary, as a result of his observations at the National Chemical Exposition, called attention to the appearance of tellurium and suggested its use as a hardener of lead, and, perhaps, of other metals. Since the writers had already undertaken a study of its action on lead and other white metals, it seems of interest to record these results in a preliminary note in order that others interested in investigating the subject may have before them such facts as have been obtained.

The tellurium used in this investigation was obtained from Superintendent A. E. Hall, of the American Smelting & Refining Co., Omaha, Neb., to whom we express thanks.

The first experiment with tellurium was carried out in an attempt to use it instead of sulphur in removing copper as an impurity from 50:50 (tin:lead) solder. The solder was made to contain 0.45 per cent copper; 163 grams of the solder was melted and to it was added 0.9 g. of tellurium, 0.733 g. being the amount necessary to combine with the copper present to form cuprous telluride. As soon as the tellurium touched the solder it burst into a glow and then seemed to form hard lumps which only slowly, and in part, disappeared. After stirring the molten mass for some time, during which a dross collected on the surface, the metal was poured to form a number of buttons. The dross was then heated to a higher temperature, when it burned to a yellow powder insoluble in both dilute and concentrated nitric acid and in a concentrated solution of sodium hydroxide. This would indicate that the insoluble residue is not tellurium oxide. On heating some of the yellow powder on charcoal before the blowpipe, the color was somewhat changed, but no lead was formed. Its action with concentrated nitric acid was to form a white powder, perhaps metastannic acid. It was not further investigated. Analysis of a button revealed the presence of 0.27 per cent copper, showing that the tellurium had removed nearly one-half of the copper.

In a second experiment 142 g. of the solder containing 0.27 per cent of copper was again melted and 1.5 g. of

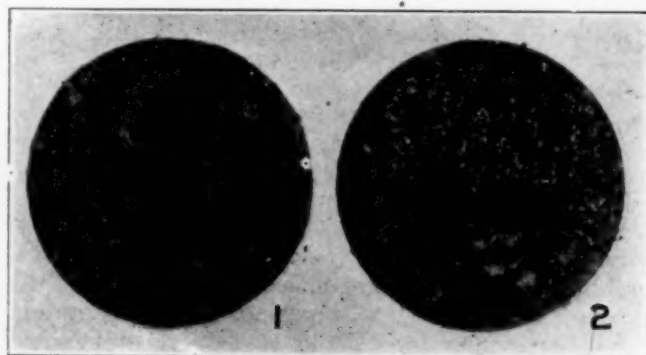
tellurium added to the just molten mass. No change in the tellurium was noted, but on heating to a slightly higher temperature the same glowing occurred as before with the formation of large pieces floating on the surface. The pieces partly disappeared after some time. Some of them were removed, powdered, and then returned to the bath. In the powdered form they were nearly white. During heating the molten bath was constantly stirred with a piece of dry, soft wood, and when most of the pieces had disappeared, the metal was poured into molds. The dross weighed 8.5 g. In this case, however, the copper was not removed, but was present in larger amounts than at first, probably due to the fact that the analysis (0.27 per cent Cu) was not representative of the original melt.

TELLURIUM AND LEAD

In order the better to interpret the results stated above a study of the action of tellurium on lead and on tin, separately, was undertaken. First, 129 g. of pure lead was just melted and upon the surface was sprinkled 1.3 g. of powdered tellurium. The tellurium glowed with the formation of large lumps mixed with a powder which floated as a dross. After heating to a higher temperature and stirring with a piece of dry wood, the metal was poured into a mold. It weighed 115 g. and the dross weighed 14.5 g. The lumps were then separated from the finer powder, which latter was a mixture of metallic particles with a yellow, non-metallic powder. The former were hard but somewhat malleable, and they, as well as the metallic powder, contained both lead and tellurium. Tellurium could not be found in the yellow powder and its nature has not been established. The lead was found to contain 0.2 per cent tellurium and had a Brinell hardness of 5.1. The lumps of dross tested 7.5 Brinell, and possessed a more metallic ring than does lead.

TELLURIUM AND TIN

Some pure tin bars were melted and poured, making four chill-cast cylinders. Two of these were used for comparison and the others, weighing 650 g., were heated just to melting. After removing them from the heat, 7 g. of tellurium was added in powdered form and stirred into the semi-fluid tin. The mass was again heated while being stirred. Some solid pieces collected on the surface and there was some solidification around the edges of the bath, though the temperature was far above the melting point of tin. Most of the floating lumps finally disappeared, leaving a dross upon the surface. No glowing was observed. Finally the metal was heated very hot and poured, making two bars. The dross, which included much metal, weighed 22 g. Tests made with



PHOTOMICROGRAPHS OF TIN AND TIN-TELLURIUM
Fig. 1. Matrix: crystallized tin. $\times 100$. Fig. 2. Bright plate-like areas of tin telluride in a matrix of crystallized tin. $\times 100$. Both etched with 10 per cent nitric acid.

the bars in an Olsen testing machine showed that the elongation as compared with that of the bars of pure tin had decreased from an average of 65 per cent to 54 per cent, while the tensile strength per sq. in. had increased from 3,800 to 4,265 lb. The bars were remelted and poured to form buttons for hardness tests and to get samples for analysis. The tests showed that the metal containing tellurium was slightly harder than the pure tin. Two closely agreeing analyses gave an average of 1.12 per cent of tellurium. This element was also found in the dross.

In order to study the structure of the metal containing tellurium, photomicrographs were made from one of the buttons, and for comparison a similar photomicrograph of pure tin. The etching reagent was a dilute nitric acid. As will be seen from an inspection of Figs. 1 and 2, the tellurium causes the formation of a large number of small particles which appear as white dots in the picture. These are probably tin telluride in a matrix of crystallized tin.

TELLURIUM WITH ZINC AND WITH ALUMINUM

Experiments similar to those carried out above were made with tellurium and zinc and with tellurium and aluminum. In neither case were more than traces of tellurium found in the treated metal, most of it apparently remaining with the dross. However, in spite of its absence in the finished products, the tensile strength, in the case of zinc, was increased from 4,955 lb. to 5,510 lb. per sq.in. and in the case of aluminum from 13,840 lb. to 14,810 lb. In the case of zinc the elongation was nil both with and without the tellurium, while with aluminum the use of this element increased the elongation from 18.5 per cent to 28.5 per cent. The hardness was not changed appreciably in either case.

An experiment was carried out in order to determine if any hardening effect would result from the addition of tellurium to an alloy of lead containing 0.5 per cent of magnesium. No increase in hardness resulted, neither was the appearance changed. It is a question whether the tellurium formed a solution or other intimate mixture with the alloy, since one part of the product gave a good test for tellurium with concentrated sulphuric acid, while a repetition of the test with another portion gave negative results. It is probable that magnesium telluride was formed and that it very largely escaped from the molten alloy.

TELLURIUM WITH ZINC-BASE DIE-CASTING METAL

One per cent of tellurium was added to zinc-base die-casting metal and the molten mass thoroughly stirred. Tests made with the chill-cast bars did not show any change in properties due to the presence of the tellurium, except that the metal appeared to be more nearly free from blowholes. In one test the metal showed the presence of tellurium; but in a subsequent test on the same bar no evidence of its presence could be found.

SUMMARY

Only two of the common white metals appear to dissolve tellurium, and these two only in small amounts. Where solution is effected the hardness and tensile strength are increased to an appreciable extent. In all cases investigated it is probable that tellurides of the metals are formed and that these are little soluble in the molten mass.

Michigan Smelting & Refining Co.,
Detroit, Mich.

Note on Schwartz Furnace Atmosphere When Melting Complex Bronzes

BY R. J. ANDERSON AND J. H. CAPPS

In the course of an investigation of the gas atmospheres in aluminum alloy melting furnaces, reported in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 25, No. 2, p. 54, July 13, 1921, an opportunity was presented to analyze the gases within a Schwartz furnace melting leaded zinc bronze and lead bronze.

A summary of the results of the analyses is given in Table I. Three samples each were taken from the three different heats, and wide variations in the percentages of carbon dioxide, carbon monoxide, nitrogen and oxygen were found. The variations were undoubtedly due to variations in the operating conditions. The last three samples, however, are fairly uniform. Comparing them with the analyses presented in Table VI of the article cited above, it is seen that combustion is more complete; CO₂ being higher, and CO, H₂, CH₄ and oxygen lower in the bronze-melting furnace.

This may be due to the fact that the melting temperature in the case of bronze is considerably higher than should normally be used for light aluminum alloys,

TABLE I. ANALYSES OF GASES IN CONTACT WITH METAL IN A TILTING, OIL-FIRED, OPEN-FLAME EGG-SHAPED FURNACE (SCHWARTZ TYPE), MELTING COMPLEX BRONZES

Composition, Constituents per Cent, by Volume						
Time Sample Drawn,	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂ , by Difference	Oxygen, O ₂
Melting lead-zinc bronze †						
3:10	14.5	0.0	0.0	0.0	84.3	1.2
3:15	13.6	0.0	0.0	0.0	85.4	3.0
3:35	4.4	2.4	0.2	0.2	78.9	13.9
11:50	18.6	16.4	1.8	0.0	63.2	0.0
11:57	17.1	24.9	2.6	0.0	55.4	0.0
12:05	19.9	2.2	3.0	0.0	74.5	0.4
Melting lead bronze ‡						
11:10	12.0	0.0	0.0	0.0	87.0	1.0
11:16	12.7	0.0	0.0	0.0	86.2	1.1
11:24	16.4	0.0	0.0	0.0	83.4	0.2

* Unsaturated hydrocarbons tested for and not found.

† 87.5 per cent copper, 10.0 per cent tin, 1.5 per cent zinc, and 1.0 per cent lead.

‡ 89.0 per cent copper, 10.0 per cent tin, and 1.0 per cent lead.

and the method of conducting the firing in the same furnace used for melting these different alloys should be altered for the alloy. Practically, however, the open-flame tilting furnace, when melting light aluminum alloys, is generally run as fast as possible so as to secure a rapid rate of melting.

A temperature of the second lead-zinc bronze noted in Table I was about 1,190 deg. C., while the furnace atmosphere at about 12 m. was 1,210 deg. C.

Conditions in Belgian Zinc Industry

Belgian zinc production in 1920 was 82,960 tons, in comparison with 19,860 in 1919 and 204,220 in 1913.

Only two Belgian plants manufacture lithopone. They are the Société Anonyme des Produits Chimiques de Wilsele, near Louvain, and the Société Anonyme Stella, at Haren, north of Brussels. Their joint annual production is 16,000 tons.

The production of other zinc products is still considerably below the pre-war figures. While 9,118 tons of zinc oxide was prepared in 1913, the figures for 1920 show only 1,500 tons produced.

Air Pollution and Wastefulness

By FREDERIC DANNERTH

A RECENT decision of the U. S. Supreme Court relating to the gas carbon black industry of Wyoming involves a number of points which affect the chemical industry in general and industrial wastefulness in particular.

It appears that the State of Wyoming (Chapter 125, Laws of 1919) passed an act which prohibits as wasteful the burning and consumption of natural gas for its products without fully and actually applying and utilizing its heat for other manufacturing or domestic purposes. It forbids owners or lessees of gas wells to sell or dispose of such gas for the manufacture of carbon or other resultant products, in the making of which its heat is not so utilized for other domestic purposes. The act limits the prohibition to cases where gas wells or sources of supply are within ten miles of any incorporated town or industrial plant. Infractions of the law will be dealt with as misdemeanors.

The case was originally heard in the District Court of the United States for the District of Wyoming, and the appeal from this decision was argued Oct. 13, 1920, and decided Dec. 13, 1920, Justice McKenna delivering the opinion of the court. The Midland Carbon Co., together with the Occidental Oil & Gas Co., both Delaware corporations, asked that the Attorney General of the State of Wyoming be restrained from enforcing or attempting to enforce the act.

CASE OF THE COMPLAINANTS

The complainants state that they had built a plant in Big Horn County at an expenditure of \$375,000, that they produce 13,000 lb. of gas carbon black per day, and that this is sufficient for making 117,000 lb. of printing ink. They also make out of that gas 1,600 gal. of gasoline per day. The Occidental Oil Co. in the course of its existence has secured mineral leases covering 1,200 acres of proved gas territory within ten miles of the town of Cowley. The company claimed that its rights under the Constitution of the United States were violated by the state law, that the proposed restrictions abolish, ruin and destroy the complainant's business while leaving it open to others to engage in the making of gas carbon black.

The present consumption of gas from the sand is 15,000,000 cu.ft. per day; the decrease in pressure for the last year has been 150 lb.; the present pressure is about 200 lb. In view of these facts, at the present rate of decrease in pressure the field will be exhausted in sixteen months and there will be no pressure to force the gas out of the sand. The present consumption of gas is about 5,500,000,000 cu.ft. per year.

POSSESSION OF THE LAND NOT NECESSARILY POSSESSION OF THE GAS

The court emphasized the fact that "possession of the land is not necessarily possession of the gas," and "the property of the owner of lands in oil and gas is not absolute until it is actually in his grasp and brought to the surface." Oil and gas, like other minerals, are situated beneath the surface of the earth, but for this one point of similarity in many other respects they greatly differ. They have no fixed *situs* under a particular portion of the earth's surface within the area where they obtain. They have the power, as it were, of self-transmission. Therefore in a previous case it

was adjudged that their use by one owner of the surface affected the use of other owners and an excessive use by one diminished the use of others. A similarity of other minerals was rejected, and the analogy between oil and gas and animals *feræ naturæ* was declared. It was hence decided that the power of the state can be manifested for the purpose of protecting all the collective owners, by securing a just distribution, to arise from the enjoyment by them, of their privilege to reduce to possession and to reach the like end by preventing waste.

VERY LOW EFFICIENCY

The process used by the Midland Carbon Co. is merely an incomplete combustion of gases in an insufficient amount of air, the flames from the different jets practically touching cast-iron channel plates. These are suspended over the flames and are moved backward and forward at a very slow rate of speed. The carbon is scraped off the plates into hoppers and carried to the packing houses by conveyors. It has been claimed by expert industrial chemists that the efficiency of the carbon black industry is very low. That the largest yield known to the producers themselves is 1.75 lb. per 1,000 cu.ft. of gas. That it has been chemically determined that 1,000 cu.ft. of natural gas contains approximately from 33 to 45 lb. of actual carbon.

WELFARE OF COMMUNITY PARAMOUNT

The Midland company stated that the money value of the carbon black was far greater than that of the natural gas. In securing testimony for its case it endeavored to show that its customers would be inconvenienced and it would meet with disaster if the supply of gas carbon black should cease. This entirely selfish point of view was given little consideration by the court, for it is generally conceded that the money which any corporation hopes to make out of its enterprise is not more important than the welfare of the community which makes the enterprise possible. The wells of the Midland company are drilled into the same sand in which the wells of the Lovell Gas & Electric Co. are drilled. This latter company furnishes gas and electricity to the town of Lovell. The sand is a "free-flowing sand"—that is, one in which the gas has free access from one part of the field to the other, consequently the gas pressure would be approximately the same at all the wells drilled into it. It was stated that the present consumption of the gas would materially interfere with the supply of gas to the town of Lovell.

STATE MAY DETERMINE IF CONSERVATION IS NECESSARY

The court held in its decision that it is for the state to determine if any conservation is necessary, and if so it also has the right to determine how far it wishes to go in exerting its power. The statute was intended only to prevent the selection of one product whose production tended to exhaust the supply of gas in a very little while.

The decree of the lower court granting an interlocutory injunction was reversed. At this time similar action is contemplated in the State of Louisiana, and it would seem that the passage of a similar law in that state was in order if only to compel attention to the systematic wastefulness of certain American chemical industries. An industrial process carried on with an efficiency of less than 5 per cent is surely worthy of some attention at the hands of law makers.

Notes on the Metallurgy of Calcium*

Survey of the Development of the Metallurgy of Calcium — Properties and Uses of the Metal and Its Alloys—Detailed Description of the Successful Methods for Preparing the Pure Metal

By P. H. BRACE

Research Laboratory, Westinghouse Electric & Manufacturing Co.

SIR Humphry Davy¹ appears to have been the first to isolate traces of calcium by the electrolysis of moist lime; though while Davy's work was in progress he received a letter from Berzelius and Pontin which described the results of their experiments on the electrolysis of the alkaline earths with mercury cathodes. Davy repeated these experiments and secured amalgams of calcium and the other alkaline earths, confirming the conclusions of Berzelius and Pontin. In 1854 Bunsen² prepared small quantities of calcium by electrolyzing an aqueous solution of the chloride with a mercury cathode and subsequently distilling off the mercury. Matthiesen³ in 1856 prepared small quantities of impure calcium by the electrolysis of a fused mixture of strontium chloride and calcium chloride.

Comparatively little interest was shown in the subject until Moissan,⁴ in 1898, published his results, which showed that nearly pure calcium could be prepared by the reduction of calcium iodide by means of sodium. In the same paper Moissan mentions the electrolytic preparation of calcium from the fused iodide. Moissan⁵ investigated his product with characteristic thoroughness, for a little later in the same year he published an extensive list of the properties of the calcium prepared by the sodium reduction method. In 1898 Bela von Lengyel⁶ gave an account of the properties of calcium prepared in a cell with a porous diaphragm. He reported a purity of 99.2 per cent, and described his product as having a color similar to that of a silver-rich gold alloy. Evidently his metal was contaminated, for the color of pure calcium is silvery-white. Borchers and Stockem⁷ described a calcium cell in which the metal was deposited in the form of a sponge on a water-cooled cathode projecting upward from the bottom of the cell submerged in the electrolyte of fused calcium chloride. A similar cell was used in 1903 by Goodwin,⁸ but he operated at a higher current density and temperature, and so caused the calcium to collect in the molten state and rise to the top of the bath, whence it was removed by means of a ladle. This was a distinct advance over the method of Borchers and Stockem.

Shortly after this, in 1904, Rathenau⁹ made the next noteworthy advance when he used a cathode which just touched the surface of the molten electrolyte, and operated it at such a current density that the surface of the calcium in contact with the electrolyte was kept molten. The cathode was gradually elevated as the metal accumulated, and an irregular rod was thus built

up. This method was commercially successful. Goodwin,¹⁰ in 1904, published the results of a rather extensive series of experiments with an apparatus of the Rathenau type, and gave a rather complete account of the physical properties of the calcium he had prepared. In 1905 Wohler¹¹ reported on his experiments in which an electrolyte containing 100 parts of CaCl_2 and 17 parts of CaF_2 was used. He believed that the low melting point of the above mixture was an advantage, but the experience of others has since indicated that there are disadvantages which more than outweigh the convenience of the low melting point. This will be referred to again in connection with some of the writer's findings.

Arndt¹² described the preparation of calcium aluminum alloys by the electrolysis of calcium chloride with an aluminum cathode. Alloys containing between approximately 20 and 80 per cent of calcium are described, but no particularly useful properties are mentioned.

In 1909 Frary and Badger¹³ published a comprehensive bibliography of calcium metallurgy, followed by a description of the results of their work with the Rathenau form of cell, and in the following year Frary, Bicknell and Tronson¹⁴ discussed the efficiency of the apparatus just mentioned, and concluded that practically 100 per cent current efficiency could be obtained by proper manipulation. They were of the opinion that pure calcium chloride made a more satisfactory electrolyte than the calcium fluoride-calcium chloride mixture of Wohler. At the same time Johnson¹⁵ published an account of a series of experiments with the submerged cathode cell of Borchers and Stockem, and the Rathenau cell; and described the development and operation of a rather novel apparatus in which the metal was deposited on a perpendicular, vertically moving iron ribbon cathode which closed the narrow-end of a V-shaped inclosure containing the electrolyte. The wall of the inclosure opposite the ribbon was of graphite, and formed the anode. The cathode current density was kept considerably lower than in the case of the Rathenau cell, and it appears that the calcium was deposited in the solid state, producing a thick plate on the iron ribbon in much the same way as metals are ordinarily deposited from aqueous solutions. The author concluded his paper with an account of the determination of the decomposition voltage of molten calcium chloride, and stated that the value lay between 2.6 and 2.8 volts. In 1909 Cowper-Coles¹⁶ patented a process for the electrolytic preparation of calcium and similar metals, the principal feature of which was the use of a cathode in

*Paper presented at the March 9, 1921, meeting of the Institute of Metals, Westminster, England.

¹*Philosophical Transactions*, 1808, pp. 343, 354.

²*Ann. Phys.*, 1854, vol. 92, p. 251.

³*J. Chem. Soc.*, 1856, vol. 8, pp. 27-30.

⁴*Compt. rend.*, 1898, vol. 126, pp. 1753-1758.

⁵*Ibid.*, 1898, vol. 127, pp. 584-590.

⁶*Chem. Zentr.*, 1898.

⁷*Z. Elektrochem.*, 1902, vol. 8, pp. 757-758.

⁸*J. Chem. Soc.*, 1903, vol. 25, pp. 873-876.

⁹*Z. Elektrochem.*, 1904, vol. 10, p. 508.

¹⁰*Proc. Am. Phil. Soc.*, 1904, vol. 43, pp. 381-392.

¹¹*Z. Elektrochem.*, 1905, vol. 11, pp. 612-618.

¹²*Ber.*, 1905, vol. 38, pp. 904-906.

¹³*Trans. Am. Electrochem. Soc.*, 1909, vol. 16, pp. 185-195.

¹⁴*Ibid.*, 1910, vol. 18, pp. 117-123.

¹⁵*Ibid.*, 1910, vol. 18, pp. 125-164.

¹⁶British Pat. 24,396 (1909).

the form of a disk whose edge just touched the surface of the electrolyte and which was rotated as the deposit collected.

In 1911 a refining process¹¹ was described, which had in view the elimination of the included chloride and other mechanically held impurities from calcium produced by the Rathenau and similar methods. In this process the calcium was melted under calcium chloride and collected under an inverted conical iron bell submerged in the molten chloride. The idea was that the calcium would separate completely from the chloride and other impurities by virtue of the differences in their densities.

Moldenhausser and Anderson,¹² in 1913, described experiments with mixed fused electrolytes in which calcium alloys with zinc and some other metals were produced. They also stated that potassium chloride might be added to calcium chloride in amounts up to nearly 25 per cent before the potassium content of the calcium produced became too great to permit the successful working of the Rathenau method. In 1920 the writer¹³ published a short account of some experiments on the electrolytic production of calcium, and described a type of cell which he believed to be much easier to operate than the conventional form in which the graphite container for the electrolyte formed the anode. This apparatus will be more completely explained below.

This brief review of the literature will show that almost an even hundred years elapsed after the discovery of metallic calcium before serious attempts were made to prepare the metal in large enough quantities to permit accurate determinations and useful applications of its many interesting properties. Between 1898 and 1910 calcium received considerable attention from the standpoint of both preparation and properties. As a result enough demand sprang up to warrant the commercial production of the metal at Bitterfeld, in Germany. During the last ten years interest seems to have lagged somewhat; indeed, J. W. Richards,¹⁴ in 1916, mentioned calcium as one of the well-known and available metals which had not received the extensive application which might be expected from a consideration of its many interesting and unusual properties. Richards pointed out the advisability of closer study of the properties and possibilities of the less commonly used metals, calcium among them. At the present time calcium seems to find such small application that supplies are not regularly carried by dealers, and, furthermore, the prices asked are out of proportion to the difficulties of preparation. It is hoped that this paper may stimulate discussion which will bring out all the present applications of calcium, suggest new ones, and put producers and prospective users on such footing that the interaction of supply and demand will operate to create a good market and a satisfactory supply at prices more reasonable than those which are now obtained.

PROPERTIES OF CALCIUM

The accompanying table gives a short list of the more fundamental properties of calcium. The numbers in the right-hand column refer to the references below.

The following condensed list of reactions may be of interest. The numbers in parentheses following the reacting element refer to the references at the foot of the page.

¹¹French Pat. 438,772 (March 22, 1911).

¹²Z. Elektrochem., 1913, vol. 19, pp. 444-447.

¹³Trans. Am. Electrochem. Soc., 1920, pp. 69-82.

¹⁴Met. & Chem. Eng., 1916, vol. 15, pp. 193-197.

FUNDAMENTAL PROPERTIES OF CALCIUM

Property	Value	Authority
Atomic weight	40.07	21
Specific gravity	1.548	22
	3.43	23
Electrical resistivity, microhms per centimeter cube	5.32	24
	4.6	25
	6.77	26
Temperature coefficient of electrical resistivity, per degree C.	0.00457	23
	0.0034	25
Thermo-electric power against lead	8.9 to 150° C.	25
Microvolts per deg. C.	14.0 to 400° C.	25
Specific heat	0°-20° C., 0.1453	27
Melting point, degrees C.	810°	28
Tensile strength, kg. per sq. cm.	612	23
Brinell hardness, 500 kg. load	42.5	Writer
Shore hardness	19-20	Writer
Heat of oxidation, calories per g. of metal	3,288	29
Heat of chlorination, calories per g. of metal	4,248	29

Carbon (30).—CaC₂ formed exothermically by direct interaction of carbon and calcium metal. Pure calcium carbide is a white solid.

Oxygen (30).—No reaction in dry oxygen at ordinary temperatures. Above 300 deg. C. reaction proceeds rapidly, forming CaO. Takes fire in air if heated above a dull red heat, and burns to oxide and nitride with vivid incandescence.

Nitrogen (30).—No reaction at ordinary temperatures. Slow combination above 300 deg. C. Heated in pure nitrogen at approximately 900 deg. C. the nitride Ca₃N₂ is formed. This nitride is a reddish-brown solid which reacts with water to form ammonia.

Chlorine (30), Bromine (31), Iodine (31).—No reaction at ordinary temperatures if these halogens are pure and dry. Above 400 deg. C. reaction goes on, becoming violent as the temperature is raised.

Fluorine (32).—Reacts violently at ordinary temperatures.

Hydrogen (30).—At temperatures near 700 deg. C. the hydride CaH₂ is formed. This hydride reacts with water and liberates the combined hydrogen, and the calcium remaining then attacks the water and liberates its usual quota of hydrogen. Calcium hydride has been used as a portable source of hydrogen for filling balloons.

Water (30).—Pure water is decomposed slowly by calcium. Hydrogen is liberated and calcium hydroxide is formed. The reaction is greatly hastened by small amounts of impurity in the water.

Carbon Dioxide (33).—At a red heat carbon dioxide is decomposed and the carbon liberated. The oxygen goes to the calcium, forming calcium oxide.

Oxides and Halides (34, 35).—The oxygen and halogen compounds of a number of metals are readily reduced by heating them with metallic calcium. Chromium and manganese are thus readily prepared from their oxides.

ALLOYS OF CALCIUM

The list of calcium alloys that have been prepared and investigated is quite large. The outstanding general properties seem to be brittleness and the tendency to the

²¹International Atomic Weights, 1920.

²²Moissan and Chavanne, *Compt. rend.*, 1905, vol. 140, pp. 122-127.

²³Goodwin, *Proc. Am. Phil. Soc.*, 1904, vol. 43, pp. 381-392.

²⁴Northrup, *Met. & Chem. Eng.*, 1916, vol. 15, p. 193.

²⁵Swisher, *Phys. Rev.*, 1917, vol. 10, pp. 610-618.

²⁶P. H. Brace, *Trans. Am. Electrochem. Soc.*, 1920, pp. 69-82.

²⁷Arciero Bernini, *Physik. Z.*, 1907, vol. 8, p. 150.

²⁸Moissan and Chavanne, *Compt. rend.*, 1905, vol. 140, pp. 122-127.

²⁹Richards, "Metallurgical Calculations," Part I, p. 18.

³⁰Moissan, *Compt. rend.*, 1898, vol. 126, pp. 1753-1758.

³¹Thorpe, "Dictionary of Applied Chemistry," vol. 1, p. 606.

³²*Ibid.*, p. 599.

³³O. P. Watts, *J. Am. Chem. Soc.*, 1906, vol. 28, pp. 1152-1155.

³⁴Perkin and Pratt, *Trans. Faraday Soc.*, vol. 3, pp. 179-186.

³⁵Perkin, *ibid.*, vol. 3, pp. 115-117.

formation of intermetallic compounds. Very few of the calcium alloys appear to have any usefulness as structural materials. Aluminum-rich alloys may find application because of their slight advantage in weight over pure aluminum. Lead alloys containing calcium and other alkaline earth metals are finding application as bearing metals for service, such as the usual white metals are put to. The following condensed abstracts will indicate the nature of the work which has been done in the field of calcium alloys.

N. Barr²² has published the results of an extensive investigation of the properties of a number of calcium alloys by the method of thermal analysis. Calcium was alloyed with thallium, lead, copper and silver, and in every case definite evidence of the occurrence of intermetallic compounds was secured.

Moldenhauer and Anderson²³ investigated the direct production of calcium alloys from fused, mixed electrolytes. Zinc, aluminum and potassium alloys were made.

Cooper²⁴ has patented alloys of calcium with aluminum, in which the calcium content may be as high as 8 per cent. The claims feature lightness, ductility and ease of machining.

Kroll²⁵ has patented the use of calcium and its light alloys as a filling for hollow steel structural members. He has claimed that, as compared with nickel-chromium steel, structures made according to his patent have the same strength with but 41.56 per cent of their weight.

Hirsh and Aston²⁶ experimented with the production of iron alloys, and state that up to 6 per cent of calcium may be alloyed with iron by reducing Fe_2O_3 in gas-tight iron cylinders. They state that calcium destroys the welding property of iron.

Watts and Breckenridge²⁷ used the brittle alloys of calcium with aluminum, silicon and manganese as reducing agents in the course of experiments on the preparation of some of the more difficultly reducible metals. The brittleness of the alloys was found a great convenience, as it enabled them to be pulverized and brought into an intimate mixture with the substances to be reduced.

Stockem²⁸ stated that calcium dissolved in cast iron with the evolution of considerable heat, and that if considerable amounts of calcium were added a scum of calcium carbide collected on the surface of the molten metal; also that calcium alloys with copper in all proportions, and that some of these alloys are useful as deoxidizers and scavengers in non-ferrous alloys.

Watts²⁹ found that calcium acted as a powerful desulphurizer of molten, low-carbon iron, but that the effect on the phosphorus content was relatively small.

Hackspill³⁰ prepared lead alloys by the reduction of lead chloride with an excess of calcium. The alloys were harder and less brittle than lead and tarnished in the air. They were slowly attacked by cold water, and more rapidly by hot water. A crystalline alloy, Pb_2Ca , was isolated by distillation *in vacuo*.

USES OF METALLIC CALCIUM

A summary of the more important uses of metallic calcium is here given:

1. As a reducing agent in the preparation of metals and alloys from their oxygen and halogen compounds.
2. As a reagent in the purification of the inert gases.
3. As a scavenger in non-ferrous metals and alloys.
4. As a scavenger, decarburizer and desulphurizer of ferrous alloys.
5. As a dehydrating agent, as in the treatment of oils and alcohols, for example.
6. As a means of fixing atmospheric nitrogen.
7. As a source of pure calcium carbide by direct reaction with pure carbon.
8. As a stiffening filling for hollow metal structural members.
9. As a constituent of a light aluminum alloy having useful properties.
10. As a hardening component in certain lead-base anti-friction alloys.

PREPARATION OF CALCIUM

There are three general methods for the preparation of calcium, as follows:

1. By the reduction of calcium compounds by metals of the alkali group.
2. By the electrolysis of concentrated aqueous solutions with a mercury cathode.
3. The electrolysis of fused halogen compounds of calcium.

Of these three methods the last is by far the simplest and most direct.

Moissan³¹ is the one who has written most authoritatively on the first method. No advance has been recorded in this direction since the publication of his researches. He discovered that calcium was soluble in molten sodium, but not in solid sodium, and that when calcium iodide and a considerable excess of sodium were heated together in a gas-tight steel container to a temperature of approximately 750 deg. C., the calcium iodide was reduced and the resulting calcium dissolved in the excess sodium, from which it crystallized on cooling in brilliant, silvery, hexagonal crystals. The sodium which was necessarily associated with the calcium crystals was removed by the action of absolute alcohol, which reagent has little effect on calcium. Moissan asserts that he obtained a purity of 99.2 per cent, and from his description of the properties of his product it is certain that it was quite pure.

Calcium may be prepared from aqueous solutions by electrolysis with a mercury cathode. Concentrated calcium chloride solution is the usual electrolyte. The cathode current density is kept fairly high. As the calcium is released it amalgamates with the mercury, and is finally recovered by distilling off the mercury *in vacuo*. Some mercury remains in the calcium even after distillation at temperatures above the vaporization point of the calcium. This method of preparation is obviously indirect and cumbersome.

The electrolysis of pure molten calcium chloride is the most direct and convenient method of securing pure calcium. When properly prepared the impurities will total less than 0.5 per cent, and will consist of included particles of chloride and traces of calcium carbide. Small quantities of calcium may be readily prepared by melting a few grams of dry calcium chloride in a porcelain crucible and electrolyzing with a current of a few amperes, using a graphite anode and a stout iron wire as cathode. Small globules will

²²*Z. anorg. Chem.*, vol. 70, pp. 352-394.

²³*Z. Elektrochem.*, 1913, vol. 19, pp. 444-447.

²⁴United States Pat. 1,224,362.

²⁵Swiss Pat. 75,891 (Jan. 2, 1918).

²⁶*Electrochemical and Metallurgical Industry*, (now *CHEM. & MET. ENG.*) 1907, vol. 6, pp. 236-237.

²⁷*Ibid.*, 1907, vol. 6, pp. 237-238.

²⁸*Metallurgie*, 1906, vol. 3, pp. 147-149.

²⁹*J. Am. Chem. Soc.*, 1906, vol. 28, pp. 1152-1155.

³⁰*Comp. rend.*, 1906, vol. 143, pp. 227-229.

³¹*Compt. rend.*, 1898, vol. 126, pp. 1753-1758.

collect about the cathode, and may be recovered by shutting off the current and allowing the melt to solidify. The writer has succeeded in building up little rods weighing a gram or so by gradually raising the iron wire as the calcium collected.

SUBMERGED CATHODE TYPE OF CELL

The earlier attempts at large-scale production resulted in the development by Borchers and Stockem of what may be designated as the "submerged cathode" type of cell. Fig. 1 is a diagrammatic representation of such a cell. A graphite shell, *A*, is closed at the bottom by a water-cooled plate, *E*, to which is fastened the upright, water-cooled cathode, *D*, concentric with *A*. The shell and cooling plate are separated by an insulating ring, *H*, of asbestos or mica. Electrical con-

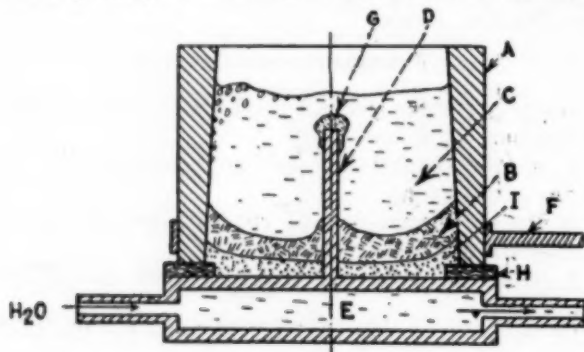


FIG. 1. SUBMERGED CATHODE CELL

A is a graphite shell containing fused calcium chloride, *C*, and forming the anode. The cathode, *D*, is fastened to water-cooled bottom plate, *E*. Calcium collects as at *G*, and rises to surface of electrolyte.

nections are made to the cooler plate and to the graphite shell, as at *F*. The floor of the cell is covered with a layer of powdered calcium oxide or calcium fluoride, *I*.

Operation of the cell is started by filling it with molten calcium chloride and electrolyzing. The calcium collects as at *G*, on the central cathode, and the chlorine is evolved at the inner surface of the graphite shell. The cooler plate maintains a layer of solid calcium chloride, *B*, on the bottom of the cell. The originators of this cell operated it under such conditions of current density and temperature that a sponge of calcium was formed about the cathode. This sponge was compacted by pressing and the chloride removed. The calcium content of the resulting mass was from 50 to 90 per cent. Goodwin worked with this cell in his earlier experiments, and found that much more satisfactory results were obtained by running the cell hot enough to melt the calcium. The globules of metal thus formed rose to the surface of the molten electrolyte, whence they were removed in a ladle and cooled under oil. The writer's experience with this method has been that it will work, but that the product is almost invariably porous and brittle and unsuitable for working into sheet and wire.

THE RATHENAU PROCESS

It appears that the most successful scheme for collecting the calcium as it deposited was developed by Rathenau. He found that a rod of calcium could be built up by using a cooled cathode which just touched the surface of the electrolyte, and operating at such a current density as to keep the surface of the calcium in contact with the electrolyte in a state of fusion while the cathode was gradually moved upward as the deposit accumulated. As successive portions of the electrolyte

were withdrawn from the bath they solidified and formed a foundation for subsequent accumulation. Thus a rod of irregular cross-sectional area was built up. In the usual form of this cell the container for the molten electrolyte was of graphite and acted as anode also.

The writer has worked with a cell of this type, and has found it to be much superior to the submerged cathode arrangement. His experience, however, has been that it was very difficult to get a rod with a cross-section approaching uniformity, and that considerable skill and experience were necessary before one could maintain the cell in operation for any extended period. It appeared that the temperature conditions within the cell were of vital importance, and that they were quite sensitive to changes in the size and position of the areas which were acting as anode. It was conceded that the operator would have much better control of the process if the anode areas were made more definite, and if means could be provided for controlling their size and position. Accordingly, some tentative experiments were then made which showed that the foregoing conclusions were correct, and taught the importance of having the mechanical details worked out with some care and with a view to convenience and certainty of operation.

The arrangement is shown diagrammatically by Fig. 2. The graphite container, *A*, for the fused electrolyte, *B*, was provided with a water-cooled bottom, *C*, which maintained a shell of solid electrolyte, *D*, during operation. A jacket, *F*, of fine graphite and lamp-black protected *A* from oxidation and prevented excessive heat losses. Two water-cooled graphite plates, *G*, *G'*, formed the anodes. These were provided with both vertical and horizontal movement. The cathode, *H*, was water-cooled and provided with gear for raising it steadily at a controllable rate. The continuous current

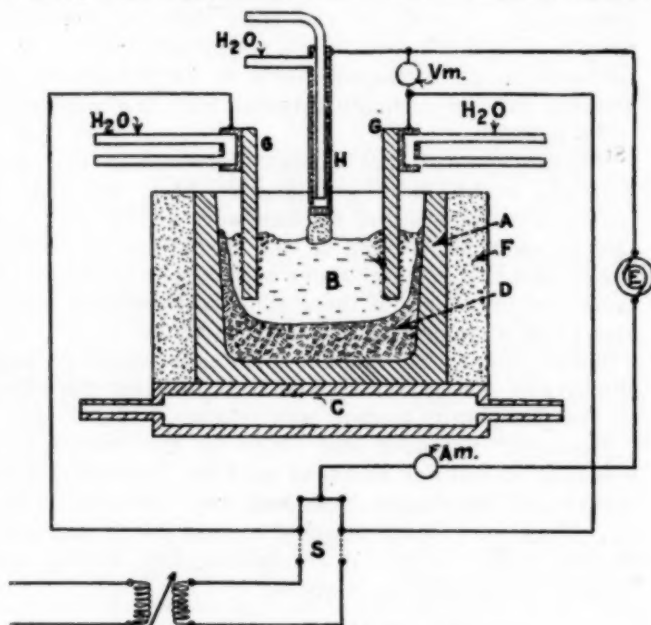


FIG. 2. IMPROVED RATHENAU CELL

A is a graphite shell, cooled by the water jacket *C*. *B* represents the fused calcium chloride. *G*, *G'* are adjustable water-cooled graphite anodes. *H* is the cathode. Current for electrolysis is supplied from a continuous current generator, *E*, connected as shown.

generator, *E*, could be connected to the cathode and anodes by placing the switch, *S*, in the position shown by the solid lines. It could be disconnected and the anodes made the terminals of an alternating-current circuit by placing *S* in the position shown by the dotted

lines. An ammeter, *Am*, and voltmeter, *Vm*, were connected as shown.

Operation of the cell was started by drawing an alternating-current arc between the tips of the anodes, and melting down enough chloride in the bottom of the cell to form a pool into which the anodes were dipped. After this the molten electrolyte carried the current and was heated thereby. Fresh portions of chloride were added and melted till the bath was brought to the desired volume. Switch *S* was then thrown into the direct current position, and electrolysis started by bringing the cathode into contact with the surface of the electrolyte.

The temperature of the cell while operating was very readily controlled by varying the separation and immersion of the anodes. It has been found most feasible to operate at constant current and to control the conditions of deposition by means of the anodes and the rate of cathode movement. In practice this cell has been found to operate very smoothly, the duration of runs being limited only by the range of motion of the cathode. The diameter of the sticks was uniform to within a very few millimeters, and the quality of the metal such that it could be rolled into rods and thin sheets without any difficulty.

The principal dimensions of a 500-amp. cell are given in the following table:

Container, Acheson graphite.
Outside diameter, 12 in. (30.4 cm.).
Inside diameter—Top, 11 in. (27.9 cm.).
Bottom, 10½ in. (26.6 cm.).
Depth, 9 in. (22.8 cm.).
Anodes, total workable area, 80 sq. in. (516 sq. cm.).
Average running area, 60 sq. in. (387 sq. cm.).
Working charge of electrolyte, 25 to 35 lb. (11.3 to 15.7 kg.).
Cell voltage, 25 to 30 volts.
Current, 400 to 500 amp.

The best results were usually obtained by running the cell with sufficient energy input to keep nearly the entire charge of electrolyte molten, only a small portion on the sides and bottom of the graphite container remaining solid.

If the cell were allowed to run cool so that thick layers of solid electrolyte formed, difficulty would be experienced when the temperature was subsequently raised, apparently owing to the release of graphite or other impurity which had concentrated in the electrolyte that had solidified during the period of sub-normal temperature. A black scum would form on the surface of the bath, which would react with the calcium being deposited and greatly disturb the delicate temperature balance at the cathode.

When the cell was running smoothly, the layer of molten metal on the lower end of the cathode was approximately ½ in. (0.3 cm.) thick. If the molten zone rose too far, a large globule would break off and float around on the surface of the bath until oxidized or cooled against the side walls. This was a very undesirable happening, as the bath was contaminated by the oxide formed and any metal free in the cell was likely to attack the anodes, disintegrating them and sending finely divided calcium carbide into the electrolyte to contaminate the calcium produced.

It has been found that from 4 to 5 units of chloride are used per unit of calcium produced, while the theoretical ratio is but 2.76 units of chloride to one of metal. The low recovery was due partly to the loss caused by the skimming of the bath which became necessary at times; to the chloride layer which formed on the calcium as it was drawn from the bath; but principally to the atomizing effect of the vigorous evolution of chlo-

rine. A fine spray of electrolyte was formed and carried up the flue by the draft sweeping out the chlorine.

ELECTROLYTES

Of the various electrolytes which have been suggested, the writer has tried calcium chloride-calcium fluoride, calcium chloride-potassium chloride, and pure calcium chloride, and is of the opinion that pure calcium chloride properly dehydrated is the most satisfactory. Both purity and complete dehydration of the electrolyte are essential if trouble is to be avoided in operation.

Satisfactory dehydration was secured by boiling the aqueous solution down with excess of hydrochloric acid and a few per cent of ammonium chloride. The white porous cake formed was broken up, mixed with additional ammonium chloride, and heated out of contact with moist air at 500 to 600 deg. C. for several hours.

Incomplete dehydration was made evident by the evolution of hydrogen at the cathode when electrolysis commenced. Oxygen was apparently freed at the anodes, greatly hastening their disintegration and causing the bath to become contaminated with finely divided graphite. The hydrogen liberated at the cathode interfered greatly with deposition, the graphite was carried to the cathode where it reacted with the calcium, and the net result was a disagreeable mess and little calcium.

If the chloride used for electrolyte contained even small amounts of the salts of sodium, magnesium or aluminum, more or less trouble was encountered, because of the fact that these metals were precipitated along with the calcium, and at some stages of the process so lowered the melting point of the deposit as to make it almost impossible to maintain operation of the cell. When using electrolyte of sufficient purity, a cell could be operated for extended periods with no difficulty and with no need for any change of the electrolyte or additions to it other than the fresh material needed to replace that used up.

The powerful reducing action of calcium was well illustrated by the fact that globules of calcium which became detached from the cathode and remained in contact with the molten electrolyte for some time picked up magnesium, aluminum and sodium from the molten electrolyte. Buttons containing several per cent of these metals have been taken from cells which have been in operation on electrolytes containing but small fractional percentages of salts of the metals first mentioned. Some of these buttons were so highly alloyed as to be quite brittle, to react but slowly with water, and to have a melting point below a red heat.

In closing it may be said that the electrolytic preparation of calcium is a simple matter if pure, dry calcium chloride is used. By "dry" is meant perfectly dry; the "anhydrous," "c.p." material supplied for drying tubes and similar applications may contain as much as 0.1 per cent of moisture, and other troublesome impurities.

CONCLUSIONS

1. Goodwin and Rathenau made important advances in the technique of the electrolytic preparation, and the "contact cathode" process of the latter has met with commercial success.

2. Certain modifications permitting the control of anode conditions have been introduced by the writer, and it is believed that marked advantages result.

3. Pure calcium chloride, completely dehydrated and free from calcium hydroxide, is a most satisfactory electrolyte.

Multiple Effect Evaporation

Discussion of the Multiplex Film Evaporator as Regards Features of Construction and Operation—
Development of Evaporator Design Since 1885—Comparison of the
Multiplex With Other Types

By BURTON DUNGLINSON

WHERE evaporation is carried out on an extensive scale, economy of heat is a fundamental factor in the efficiency of the apparatus. In a vacuum-evaporating problem it is obvious that there will be no economy of steam for evaporation if a single-effect vacuum evaporator is used, as the lowering in boiling point of the liquid due to vacuum does not conserve sufficient energy to compensate for the energy used in driving the vacuum pump plus the radiation losses. The only reason single-effect vacuum evaporation is resorted to is the fact that low-pressure exhaust steam can be used to advantage and where delicate liquids are being handled the lowering of boiling point prevents decomposition which would occur at higher temperatures.

Multiple-effect vacuum evaporation was introduced with a view of conserving as much heat as possible by utilizing the latent heat of condensation of the steam evolved from the various vessels. Thus, in a quadruple-effect evaporator exhaust steam can be used for heating the liquid in the first effect. The process of evaporation centers on the temperature difference between the heating medium and liquid to be heated. This is obtained in the first effect by a slight vacuum created by the pump above the liquid and the higher temperature of the exhaust steam used as a heating medium. If the evaporated steam being evolved from the liquid in the first effect is to be utilized as a heating medium in the second effect, it is clear that there must be a sufficient temperature difference between the liquid coming from the first effect and the steam being evaporated from same. The temperature difference is obtained by creating a larger vacuum over the liquid in the second effect, and a similar procedure is followed for the third and fourth effects. The actual vacuums usually desired are: First effect, 2 in. mercury; second effect, 6 in. mercury; third effect, 14 in. mercury; fourth effect, 28 in. mercury.

SYSTEMS EMPLOYED

This system of multiple evaporation (as well as any other system) allows the available heat of evaporated water, as steam, to be utilized to advantage. Theoretically, if radiation losses and other factors did not interfere with the laws, one drop of water during process of evaporation should produce just the same amount of heat as was originally transmitted to heat it up to boiling point and complete evaporation. The energy contained in this steam, if transmitted to another drop of water while being cooled to its original temperature, would be sufficient to evaporate another drop of water under the same conditions and so on *ad infinitum*. Unfortunately this theoretical condition cannot be approached in actual practice, as radiation losses are unavoidable and the condensed steam usually

passes away as hot water and retains a fair number of heat units.

The nearest approach to theoretical conditions would be the use of the largest numbers of multiple effects possible with due consideration to mechanical operation and costs of installation. Sextuple-effect evaporators are known but are very rarely used. Their use is confined mainly to processes in connection with soap and paper manufacture, and this applies also to quintuple effects. It is questionable whether the increased efficiency due to the greater heat units developed in 1 lb. of steam compensates for the extra cost of installation and operation in these styles of evaporators.

Quadruple-effect evaporators are quite common in industry, being used mainly in connection with sugar plantations and refineries, where very large quantities of liquids are handled. Triple-effect evaporation is generally used for most operations where liquids have to be concentrated from a density approaching water to 30 deg. Bé. (sp.gr. 1.26) or thereabouts. This type of apparatus is generally accepted as being the "happy medium," where initial cost, floor space, operating costs and economy counterbalance one another.

GENERAL DEVELOPMENT OF APPARATUS

The development of evaporator design has been very gradual and up to recently has been marked by no decided revolution. From the inception of the jacketed pan to the vertical and horizontal tube evaporator no epoch-making devices were introduced. In fact, it is quite a common practice today to evaporate milk and some food products in a steam-jacketed pan, with addition of coils, to permit perfect cleaning after each run. Naturally the efficiency of such equipment is very low, when compared to the tubular evaporator, which maintains a more rapid circulation.

The standard tubular evaporators are built to operate on two principles: One in which the liquid to be heated circulates through the tubes, and the other in which the liquid to be heated is circulated around the tubes. From a standpoint of easy cleaning and general efficiency the evaporator which permits the liquid to circulate through the tubes is the more acceptable.

When a liquid is heated, convection currents are set up, which ultimately produce circulation. This circulation would be impeded by the formation of steam and dissolved air bubbles if means were not introduced for a fairly violent agitation to free these "insulators" from the tube walls. This is accomplished by introducing one or more wide-bore circulating tubes, through which the liquid passes downward. It is a most natural phenomenon, as the heat transmitted through a narrow-bore tube is much greater per unit cross-sectional area than that through a wide-bore tube, hence creating a temperature difference between the liquid in the nar-

row- and wide-bore tubes. Thus the direction of flow is maintained in a positive way by ascending the small-bore heating tubes and descending the wide-bore circulating tubes. Most standard evaporators have the heating elements of tubes about 2 in. in diameter.

Arguing as above, tubes of narrower bore would be expected to transmit more heat per sq.ft. and maintain a much more rapid circulation, and this has proved to be the case in actual practice. A wide-bore tube evaporator, the usual standard type of plant, with 2-in. tubes, must have a greater diameter than a machine of same heating surface using tubes of smaller diameter. It is also plain that with the former type of evaporator, owing to the absence of any separating device for the steam and liquid adjacent to the top tube plate, a greater free space must be allowed for complete separation of liquid drops from the steam, which would otherwise be carried over to the condenser and wasted. To make doubly sure of this important point, a vapor baffle piece is usually embodied in the head of the evaporator.

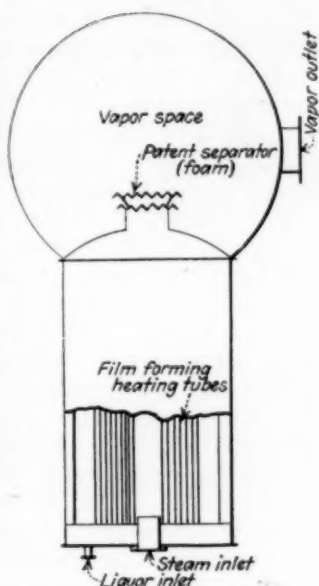


FIG. 1. CROSS-SECTION OF ONE EFFECT MULTIPLEX FILM EVAPORATOR

ELEMENTS OF DESIGN

The four elements constituting a complete evaporator are: (1) The nest of heating tubes, commonly called a "calandria" and embodying the shell and tube plates. (2) The bottom plate, in which the liquor discharge pipe is fixed. (3) The vapor space or section, usually called the "belt piece," which in a standard evaporator must be of sufficient height and volume to prevent entrainment of foam and drops. (4) The vapor and drop separator or "save-all," which is embodied in the design of the cover plate. This is usually an inner and an outer pipe, which change very quickly the direction of flow of the vapors and result in the trapping of any entrained drops, which pass back to the liquid being evaporated, before the vapors travel to the next vessel or to the condenser. This design embodies all types of vacuum evaporators, and the modification, improvisation and disposition of the contained parts cover the patent types of equipment.

STEAM CONSUMPTION

Steam consumption in most standard types of evaporators varies very little for the different designs and the following evaporating figures will serve as a guide to actual practice. Per pound of steam used, the quantities of water evaporated will be:

In a single effect vacuum evaporator,	0.8 lb.
" " double " " "	1.6 "
" " triple " " "	2.7 "
" " quadruple " " "	3.1 "

The heat losses met with are usually due to: (1) Radiation from the large surfaces of calandria, belt piece and connecting vapor pipes; (2) hot condensed

water passing to vacuum pump, and (3) bad transmission of heat, due to sluggish circulation and consequent incrustation of tubes with deposits from liquid being evaporated.

Efficient condensation is a prime factor in maintaining a high vacuum on the apparatus and it will be readily understood that the more complete the condensation the smaller sized vacuum pump that will be required. For given quantities of liquids treated in a single, double and triple effect, the size of the vacuum pump and condenser will be cut down according to the increase in the number of effects. The liquid under treatment is usually carried from one effect to the other by means of the different vacuums operating in the vessels. A liquor-withdrawing pump is required to discharge the concentrated product from the last effect.

COLOR OF LIQUID

The conditions operating on the last effect in a standard triple-effect evaporator are not conducive to production of a good colored product, free from contaminated decomposition bodies, because to obtain the necessary heat transmission there must be sufficient liquor present at all times to cover the tubes. This means a fair volume of material which must always be present at the finished density, and consequently there will be a prolonged heat-treatment of a large proportion of the liquid. In most cases the time of contact in a standard single- or triple-effect evaporator varies from one to ten hours according to the required density, and as the liquid is in constant though sluggish circulation most of the time, it is subjected to heat-treatment which is detrimental to the finished product, unless particularly high vacuum is maintained together with the use of exhaust steam having a very low pressure.

EXPERIMENTAL WORK

With the desire to eliminate these undesirable factors, experiments were made with a view of increasing the velocity of the liquid in the heating tubes and so determining the time of contact desirable, in the form of a thin film; producing the concentrated product and if possible removing all liquid immediately this concentration is reached. The first practicable plant to produce these results was of the Kestner type, and the design of this plant in the main has not altered materially from its inception. The tubes of this evaporator are about 1 in. in diameter and are not less than 20 ft. long. It will be seen that with such a long tube mechanical difficulties are likely to be encountered, such as sagging of the tube due to its weight and consequent strain of the top tube plate, with the result that leaks will develop.

Owing to the enormous head room required for the plant a triple-effect evaporator must be composed of three single-effect units extended over large floor space with interconnection vapor pipes, and the time of contact with the 20-ft. tube is extremely large, although film evaporation will reduce the deterrent effect of the heating medium to a minimum.

For quite a number of liquids it has not been possible to employ multiple-effect apparatus, because materials which are sensitive to a high temperature could not be evaporated in such equipment without suffering injury, as the operation of a multiple-effect evaporator, say of the triple-effect type, requires evaporation temperatures calculated from the vacuums employed, and

actual readings on a large scale, up to about 176 deg. F., and if a larger number of effects is used, still higher evaporating temperatures are required.

For small or medium quantities of liquid and where the work performed is more or less intermittent, the use of a multiple-effect evaporator is precluded because of the time occupied in starting and stopping the apparatus. The large floor space required and the comparatively high first cost compared with that of a single-effect evaporator and many other disadvantages to be overcome caused experimental work about ten years ago to be directed to mechanical efforts toward a film type of evaporator with a short tube, which, by reason of its construction, would allow three effects to be superimposed, thus utilizing no more floor space than is required for single-effect evaporator and at the same time so calculating the head room that a barometric discharge condenser could be employed if so desired.

Such an evaporator required an immense amount of detail work in design and experiments under actual large-scale conditions before the desired result could be obtained. It was found that although a thin film of liquid was induced through scientific distribution of steam, no foam was experienced until the liquid left the tubes at very high velocity.

MULTIPLEX EVAPORATOR

This mixture of liquid, foam and evaporated steam required some mechanical device to insure complete separation and experiments resulted in a type of foam separator which arrests the high velocity of the liquor and steam and gives a quick change of direction with consequent complete separation. Even with this new type of evaporator, called a "Multiplex," high temperatures in the first effect could not be avoided, but in consequence of the special construction the quantity of liquid contained in each separate effect and under treatment at one time is so small that the liquid remains in the tubes only one to two minutes as a maximum, and is then drawn off immediately after passing through the foam separator into the next effect, which is at a lower temperature, owing to the higher vacuum being maintained.

It will be readily understood that owing to the high velocity and short distances the liquid has to travel through the tubes, not more than 6 ft., the time of contact is exceedingly short. The effect of high temperature is instantaneous with consequent high-grade product and maximum evaporation owing to the formation of film inside the tube.

A very important development in connection with these high velocities obtained in film evaporation is the scouring effect of the liquor passing through the tube, which has been found to prevent formation of scale or other bodies which would result from prolonged heat-treatment. In fact, an experience over six years in the treatment of a very sensitive liquid has shown the heating tubes to be absolutely bright and clean and free from any foreign deposit.

Most liquids will stand the temperatures encountered without suffering practically any injury, and their quality is affected only when the high temperatures act on them for a considerable time. This explains why, notwithstanding the high temperatures met with in the first effect, no deterioration of the quality of the liquid concentrate takes place in the Multiplex type.

The mode of operation is very simple, the apparatus

being set to work by putting the air pump in action and setting the various liquor and foul air valves distributed on a working platform from an angle of 90 deg. The vacuum sucks in the liquid which is to be concentrated through a control valve and pipe coupled to the feed tank, and the concentrated liquid is ejected continuously through a discharge pipe.

The degree of concentration is controlled by the volume of liquid introduced and the achievement of making a direct and immediate concentration from the strength of liquid entering the apparatus to the finished product will be considered unique. Once the valves have been set and the apparatus is operating, it will work continuously without any further attention.

Fig. 1 shows cross-sectional view of one effect of this Multiplex-film evaporator, and Fig. 2 will show triple-effect evaporator with three of these effects superimposed. This evaporator is complete with surface condenser and plunger type of vacuum pump. The apparatus is absolutely complete, with its feed tank, liquor discharge pump and accessories, and it will be noted how extremely small is the amount of floor space taken up. Its operation is described thus:

When the apparatus has been exhausted of air, the liquid to be concentrated enters through a pipe coupled to the feed tank into a double jacket, where it rises to a uniform height in the tubes, which are surrounded with steam entering through the valve. The liquid very soon gets into ebullition and gives off steam and its contained permanent gases. In the lower part of the heating tubes the steam itself forms bubbles, and as these bubbles are surrounded by the liquor while the steam volume is increasing constantly due to the heat contact, the liquid very soon forms a stream of increasing velocity. The bubbles tend to travel toward the center of the tube, and as a result of this the liquid attaches itself to the tube walls and the steam acts as a carrying medium, driving the liquor further up the tube and still in contact with the tube walls.

The middle and upper parts of the tubes are, therefore, no longer filled with liquid and the tube walls are still wet with it traveling at a high velocity. The bubbles of froth formed in

the lower part of the tubes are broken up so that the liquid leaving the end of the tubes in the form of drops meets the foam separator, where change of direction results in the separation of the liquor and steam. The velocity of the steam between the foam separator and tube outlet is so great that the drops do not have sufficient time to fall, but are blown toward the separating device, where the liquid settles to the floor of the vapor space in the evaporator and thereafter rises through a liquor-conducting tube which communicates with the next vessel maintained at a higher vacuum.

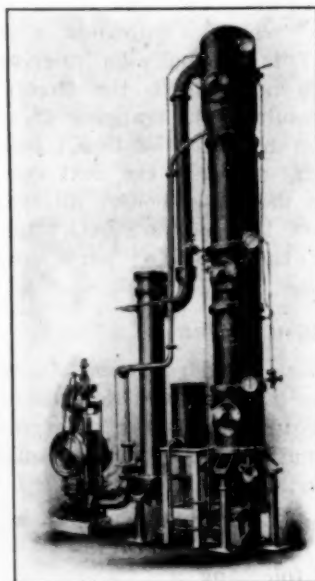


FIG. 2. COMPLETE ARRANGEMENT OF TRIPLE EFFECT MULTIPLEX EVAPORATOR

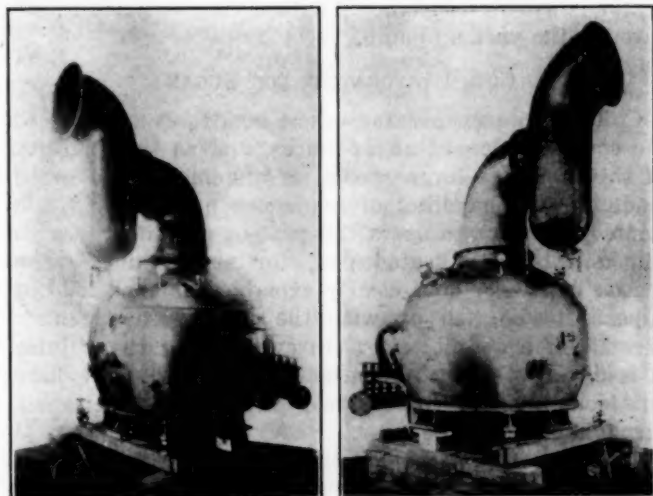


FIG. 3. COIL TYPE VACUUM PAN, 12 FT. DIAMETER, MODEL OF 1885

The vapor from the first effect rises to the second heating compartment and there serves as a heating medium and the liquor passes into the next effect, where the process of evaporation is repeated in the same way as in the first effect, with the same separation and treatment in the third effect, from which the liquor is drawn off after it has passed through the evaporator only once and has been concentrated to the desired degree. The vapor from the last effect is conducted by means of a vapor pipe to the condenser maintained under vacuum by means of the pump.

MECHANICAL ARRANGEMENT

The simplest way of arranging the effects in this type of film evaporator is to place them one above another, and this can be done for all ordinary problems, but where large quantities of liquid have to be handled it may be advantageous to arrange the effects alongside each other, although the floor space taken up is much smaller than that required for a standard evaporator.

As already pointed out, owing to the mechanical construction, the liquor cannot rush through the tubes in the form of froth, as it very soon adheres to the tube walls in a thin layer and evaporates further without being impeded by formation of froth and pockets resulting from the release of uncondensable gases. These last two factors interfere very much with evaporation in ordinary types of evaporators, and this explains why much greater efficiency can be obtained in the film type of apparatus. The central entrance of steam into the heating space causes and maintains an energetic circulation, so that all the heating tubes are heated with the utmost possible uniformity and no pockets are formed in which deleterious gases can collect.

For liquids which are sensitive to the influence of temperature, such as glue, tanning materials, food products, etc., the apparatus is constructed in such a way that the whole amount of liquid contained in contact with the heating surface in the apparatus is only a few gallons. Every particle of liquid that remains, therefore, is only a few minutes in the apparatus and is then forced up by the liquid following it.

COST DATA

To permit of comparison as to the actual saving in multiple-effect evaporators over single-effect, working

balance sheets have been drawn up. The cost figures stated have only been estimated and the capacity of the apparatus is, in each case, assumed to be ten tons, or 20,000 lb., of water evaporated in ten hours. The cost per ton of steam is taken at \$0.15 and the cost of 32 cu.ft. of water at \$0.005 and the cost of one horsepower-hour at \$0.01.

1. Single-Effect Vacuum Evaporator, Ordinary System:	
Steam consumption, 20,000 lb. at 1.05 = 10.5 tons at \$0.15.....	\$1.57
Water consumption, 10 tons \times 25 = 250 tons at \$0.005.....	1.25
Power required, 5-hp. 10 hr. = 50 hp.-hr. at 1c.....	0.50
Cost of evaporating 20,000 lb. of water daily.....	\$3.32
2. Triple-Effect Multiplex Evaporator:	
Steam consumption, 20,000 lb. at 0.4 = 4 tons at \$0.15.....	\$0.60
Water consumption, 10 tons \times 10 = 100 tons at \$0.005.....	0.50
Power required, 2 hp. 10 hr. = 20 hp.-hr. at 1c.....	0.20
Cost of evaporating 20,000 lb. of water daily.....	\$1.30
3. Quadruple-Effect Multiplex Evaporator:	
Steam consumption, 20,000 lb. \times 0.3 = 3 tons at \$0.15.....	\$0.45
Water consumption, 10 tons \times 7.5 = 75 tons at \$0.005.....	0.37
Power required, 2 hp. 10 hr. = 20 hp.-hr. at \$0.01.....	0.20
Cost of evaporating 20,000 lb. of water daily.....	\$1.02

DEVELOPMENT OF EVAPORATOR DESIGN

The original evaporators, utilized on a large scale for the production of concentrated commodities, were coil pans of beautiful design and artistic curvatures; all hand made and polished to give the machine a pleasing appearance. It must be remembered that at this time, from about 1812 to 1885, there were no drawings used in the workshops. The drafting room was unknown and reference to Fig. 3, showing the 12-ft. diameter copper vacuum pan, made in 1885, will show that there is a decided absence of corners and an avoidance of perpendicular sides, in order to maintain a gradual change in velocity of the vapors, thus cutting down frictional resistance. In those days the prevailing opinion was that sharp curves interfered with the operating of the pan and therefore any modification in the design which would tend to influence the results was discarded.

It will be noted that there is an extremely large space for the liquor with a comparatively small vapor space and only coils were used for heating. The general design is made with a view of facilitating manufacture rather than a scientific basis for efficient operating. Evidently no calculations were made as to the yield of vapor, and the change of direction in flow of this vapor,

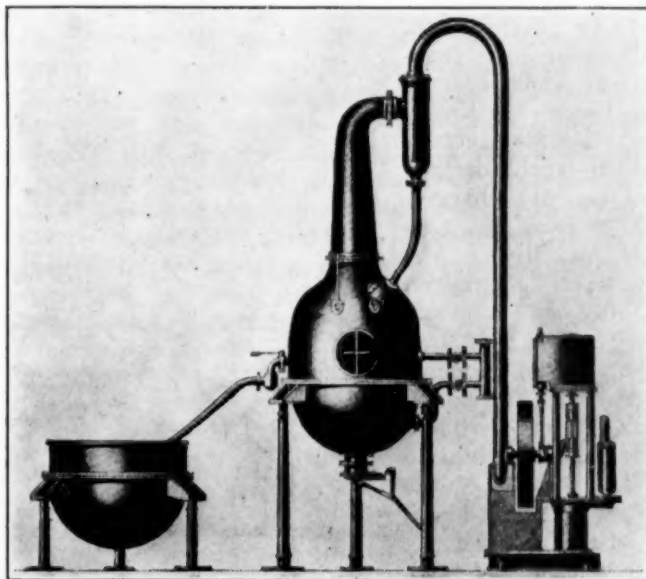


FIG. 4. STEAM-JACKETED VACUUM PAN

for the prevention of entrainment, simply depended on a baffle plate which was included in the external save-all—this being furnished with a return pipe leading to the evaporator.

MILK EVAPORATING PANS

The semi-spherical bottom was evidently included to facilitate complete draining of the concentrated liquid. While the steam-distributing arrangement, comprising header, angle valves and pipes leading to the various coils, is primitive, the solid, rugged, artistic design of this evaporator would insure long life but extremely low efficiency. The present milk pans, as shown in Fig. 4, do not depart much from the above basis of design.

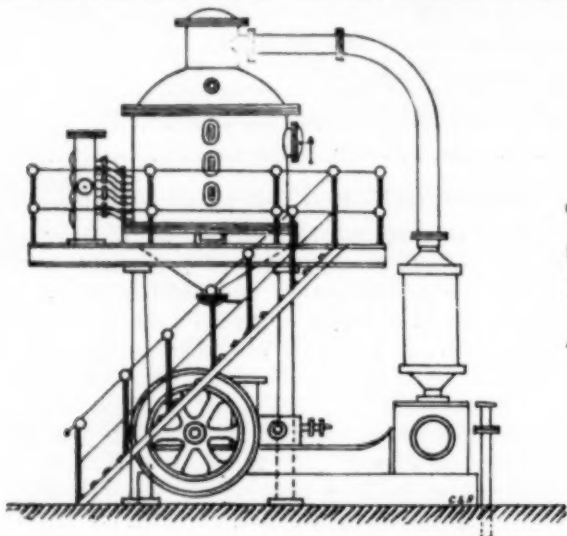


FIG. 5. COIL TYPE VACUUM PAN WITH JET CONDENSER

There is the same contour, with lengthening and widening of the vapor space and an elongation of the dome, with a more scientific application of the save-all for entrainment. The heating arrangements are still of the coil type, supplemented by a steam jacket, the probable reason being to prevent any corners where material would deposit.

One essential feature which influences the design of pans for food products is the rigidly enforced law that there must be no cavities or projections which would not be easily accessible, as the interior of the pan must be cleaned thoroughly after every run. Otherwise any depositions would eventually become the breeding place for bacteria, which would destroy subsequent charges. These pans are usually of strong and substantial make, consisting of a steam jacket or casing, mounted on columns, fitted with inner copper bottom suitably flanged and joined to the jacket by means of wrought-iron rings, secured by screw bolts and nuts. The head of the evap-

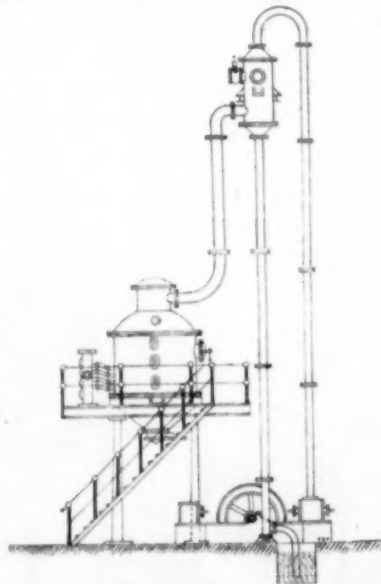


FIG. 6. COIL TYPE VACUUM PAN WITH BAROMETRIC DISCHARGE

orator is usually constructed with a view to avoid losses through the vacuum pump.

COIL EVAPORATORS FOR SUGAR

Coil vacuum evaporators were admirably adapted to the concentration of sugar juices, and as the quantity of this liquid is large special arrangements had to be made for the handling of mammoth quantities. It is common practice to use a coil pan, or combination of a coil and tubular heated pan, for sugar juice. The reason has never been clearly explained or analyzed but appears to be tied up with the production of sugar crystals of a definite size. In evaporating sugar juice it is usual to carry the concentration to a point where an inoculation with crystals will produce crystals throughout the whole mass.

This means that the coil type of pan insures a large body of liquid out of contact with the heating surface (the coils being arranged around the sides and bottom) and thus allows crystallization to proceed uninterrupted. Of course there is also the presence of soluble salts in the juices which deposit on the heating surface, owing to the fact that circulation is sluggish toward the end of evaporation. The coils are easily subjected to inspection and cleaning, thus insuring a popular tendency toward the adaptation of this type of pan for this particular problem.

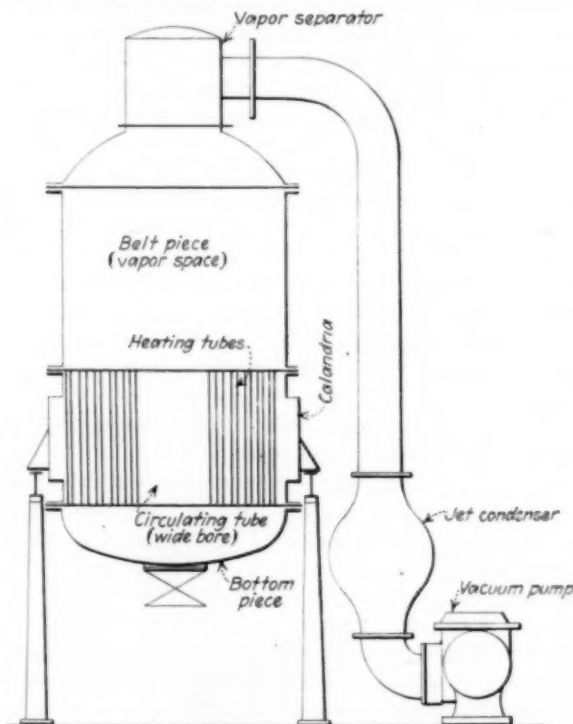


FIG. 7. VERTICAL TUBULAR CIRCULATING EVAPORATOR

These evaporators are usually made in sizes up to 15 ft. in diameter, and as such a large machine requires a proportionate vapor pipe, means had to be found to modify the existing external save-all, which was a separate piece of apparatus coupled to the dome of the pan. This resulted in the development of an internal save-all, comprising an integral part of the evaporator. Fig. 5 shows a general arrangement of such an evaporator with a jet condenser and wet vacuum pump, while Fig. 6 shows the same evaporator with a barometric condenser and dry vacuum pump.

As industry developed there were demands for an evaporator of large heating surface, low floor space,

large vapor space and an arrangement whereby the crystals deposited during evaporation could be removed without interfering with the process. The tubular evaporator was therefore developed in both the horizontal and the vertical type, having much greater heating surfaces per square foot of floor space than the coil type. The large vapor space was made to contend with the heat-treatment of the liquids which are apt to foam under vacuum, and the internal save-all device was also embodied in such a design. It will be noted how the tendency of design is toward an increased height with proportionate diameter. Such an evaporator is used almost universally for problems where crystals are deposited during the process. A cross-sectional view of this type of evaporator is shown, minus the "salt pot," in Fig. 7. The effects are arranged alongside each other, and a comparison with the Multiplex triple-effect evaporator in Fig. 2 will show the important saving in floor space and ease of operation introduced by using this latter machine. The cross-sectional diagram (Fig. 1) shows the method of heating and separation of concentrated liquor from the evaporated steam in the Multiplex evaporator. The accompanying tables show tests of this evaporator handling various solutions.

OPERATING TESTS ON GELATINE LIQUOR WITH MULTIPLEX TRIPLE-EFFECT EVAPORATOR

Construction:	3 superimposed effects, all copper, tinned inside
Weak liquor:	In at 0.2 deg. Be. } 64 per cent evaporation
Strong liquor:	Out at 6 deg. Be. }
Water evaporated:	= 5400 lb. per hour
	= 11 lb. per sq. ft. of heating surface
Steam pressure:	Exhaust steam at 3 lb.
Steam used:	1 lb. per 2.78 lb. of water evaporated
Water in:	80 deg. F. } Surface condenser used
Water out:	110 deg. F. }
Temperature of finished gelatine from last effect = 130 deg. F. at 27 in. mercury vacuum.	

OPERATING TESTS ON MALT SIRUP WITH MULTIPLEX TRIPLE-EFFECT FILM EVAPORATOR

Construction:	3 superimposed effects, cast iron with copper tubes
Weak liquor:	Wort at 4 deg. Be.
Strong liquor:	Out at 28 deg. Be.
Water evaporated:	10,000 lb. per hour
	= 10 lb. per sq. ft. of heating surface
Steam pressure:	Exhaust steam at 5 lb.
Steam used:	1 lb. per 2.8 lb. of water evaporated
Water in:	70 deg. F. } 30 deg. F. rise, using 14,000 gal. per hour,
Water out:	100 deg. F. } with jet condenser and wet vacuum pump
	= 1.4 gal. per lb. of steam evaporated
Temperature of finished malt sirup from last effect at 27 in. vacuum = 126 deg. F.	

EVAPORATION OF ALUM SOLUTION IN MULTIPLEX VACUUM TRIPLE-EFFECT

Weak liquor:	In at 27 deg. Be.
Strong liquor:	Out at 45 deg. Be. at 76 deg. C. (solid on cooling)
Steam pressure:	124 lb. per sq. in.
Steam used:	1 lb. per 2.78 lb. of water evaporated
Water in:	At 5 deg. C. } 7 deg. C. difference
Water out:	At 12 deg. C. }
Water used:	21 gal. per lb. of steam evaporated
Note: The solution entered the evaporator at a density which is usually the finishing point for most liquors in a triple effect.	

Microscopic Lenses

A committee of the A.S.T.M. recommends that the term "lens" be used to refer to the combination of simple lenses which makes up the objective, by means of which a real image of the object is produced within the tube of the microscope, or the ocular, or eye piece, which enlarges the real image formed by the objective in the focal plane of the ocular. The lens system includes both objective and ocular.

In addition to the magnification or increase in size of the image with respect to the object produced by a lens, the resolving power or ability to make visible fine detail is of great importance. The magnification produced by an objective may be determined approximately by dividing 250 mm. (the normal reading distance) by the equi-

valent focal distance of the lens. The resolving power depends upon the numerical aperture (N. A.) which in turn depends upon the angle of aperture, x , and the refractive index, a , of the medium between the lens front and the object, e.g., cedar oil in oil immersion lens.

$$N. A. = a \sin \frac{x}{2}.$$

On account of the shape of a lens, light focused from near the edge of the lens is not brought through the same point as light passing through the central part of the same lens. This defect is termed spherical aberration. In a somewhat similar manner light of different wave length (color) does not all focus at the same point; this is chromatic aberration.

Achromatic objectives are constructed by a suitable combination of optical glasses of different indices of refraction so that correction for two colors, red and violet, is made, thus reducing chromatic aberration considerably. In apochromatic lenses this correction is carried very much further so that three colors are brought to the same focus.

Canadian Glass Industry in 1918

The mining, metallurgical and chemical branch of the Canadian Bureau of Statistics has just issued an account of the glass industry of the dominion in 1918. It may appear to be a late date to issue statistics for the year 1918, but it should be remembered that the Bureau of Statistics is a comparatively new department, that Canada has been at war, and that about 7 per cent of the whole population was mobilized for the actual fighting line, while a very large number of men were employed in the manufacture of munitions and supplies for the army. This made a big inroad on a total population of less than eight million, consequently many departments have suffered and have not yet gained pre-war efficiency.

During 1918 nine firms were engaged in the manufacture of glassware; of these six confined themselves to the manufacture of lamp and lantern chimneys, drinking glasses, bottles and other pressed and blown glassware; two to vials and chemical glassware, and only one to sheet glass. The total production of glassware was valued at \$6,578,602, of which ware to the value of \$35,367 was exported. On the other hand, Canada imported glassware to the value of \$5,430,873, showing that the country produced only 54.9 per cent of its actual requirements. The total capital invested in the industry was \$7,443,525, employment was given to 2,322 men and women, and \$2,221,563 was paid in wages. The raw material consumed was valued at \$2,056,739 and the fuel at \$598,886. Miscellaneous expenditures chargeable to manufacturing amounted to \$989,747, so that the total expenditures were \$5,882,295.

The following table gives the quantities and values of the raw materials consumed, all of which, with the exception of the soda ash, sodium nitrate and lead oxides, were of Canadian origin:

	Quantity	Value
Silica sand, tons.....	40,344	\$155,854
Soda ash, tons.....	13,468	635,068
Sodium nitrate, tons.....	95	7,905
Limestone, tons.....	4,490	18,076
Lime, tons.....	2,190	18,046
Carbon, tons.....	7	140
Arsenic, white, lb.....	68,314	8,694
Manganese dioxide, lb.....	18,535	1,414
Litharge and red lead, lb.....	169,986	17,764
Other chemicals.....	.....	74,556
Miscellaneous, including crude glass and tubing.....	.....	751,276
Boxes, cases, etc.....	.....	367,946
Total.....	.....	\$2,056,739

Selection of Fuel for Industrial Heating*

THE selection of fuels for industrial heating should be based upon appreciation of the radical difference between the price of fuel on the one hand and the quality and cost of product resulting from the generation, application and utilization of heat on the other.

The result sought from the application of heat is produced not by fuel or heat alone, but by a combination of equipment, fuel and operative. The nature of the heating process, the type and size of furnaces adapted to the manufacturing requirements, the plant conditions, the personnel, and price of available fuels or electrical energy are the controlling factors. Each of these must be considered, any one of which may influence the final choice.

COST PER B.T.U. DOES NOT TELL WHOLE STORY

The practice of selecting fuel on the basis of thermal value and price is both inaccurate and misleading unless at the same time proper consideration is given to other essentials which largely determine the suitability of fuel and equipment regardless of price or thermal value. Otherwise no other form of fuel could compete with bituminous coal burned in the open grate or blacksmith fire.

The form of equipment must be considered with reference to the manner of applying and utilizing the heat and of handling the material to be heat-treated, because these essentials are as directly linked to the quality and cost of finished product as are the price of fuel or method of generating heat, whether it be through combustion or the arc, induction or resistance methods of releasing heat from electrical energy.

Whenever there is a difference in physical or chemical form of fuel, or in mechanical form of equipment, there is a difference in economic value regardless of comparative thermal value.

It is as illogical to compare different forms of heat energy with regard to a certain result as it is to compare electricity with any one form of fuel on the basis of thermal value, unless proper consideration is given to the form of equipment adapted to each.

In industrial heating, as in illumination or transportation, much of the advantage frequently credited to some one form of energy is actually due to the appliance employed in connection with it. A different design of appliance or method of operating may reverse conclusions based on thermal value.

Frequently the "form value" of a suitable combination of equipment and fuel will prevail regardless of price. This is illustrated by the practice of using comparatively expensive gas for intermittent cooking operations in the kitchen in preference to comparatively cheap coal, which under different service requirements is preferable for heating the house. The advantages of incandescent electric lamps for the illumination of the interior of a railway coach may well be accompanied by the use of oil lamps as signals at the end of the train.

A FIELD FOR EACH FUEL

The nature of the heating process, manufacturing requirements and plant conditions may in many in-

stances make city gas at \$1 per thousand cubic feet economically preferable to oil at one cent per gallon or coal at \$1 per ton. In other instances, electricity at a very much higher price, based on energy cost, is given the preference because of the operating advantages made possible by a specific form of electric energy and appliance.

Frequently a fuel such as bituminous coal may be attractive on the basis of price but objectionable in form, or *vice versa*, as in the case of gas or electricity. Gases of the same physical form may vary greatly in chemical composition, which in itself may limit the field of usefulness regardless of price. Suitable furnace design may overcome these objections. Thus the use of bituminous coal is made possible in enameling furnaces by the use of a muffle, which might be unnecessary in electric furnaces in which gases, if any, originating from the resistance material did not affect the product to be heated.

The innumerable factors controlling the selection of fuel and the generation, application and utilization of heat for industrial or domestic purposes denote a field of usefulness, in suitable apparatus, for all varieties of solid, liquid, gaseous and electrical fuel or heat energy. Expansion in the use of any one form automatically follows the development of apparatus for converting that form of energy into useful service. The apparent relative economic value of the different forms on the basis of price at the moment may be changed in the future, as it has been in the past, by the development of better methods of heat application and more efficient apparatus to make possible either a different result or to accomplish the same result at less cost, by decreasing the amount of energy required without any change in the price.

COMPARATIVE FUEL PRICES ON B.T.U. BASIS

The chart gives a means for comparing fuels on the basis of their B.t.u. cost—by direct comparison of the price of one fuel with the price of another; by comparison of the relative costs per million B.t.u., or, on an assumed cost per million B.t.u., reading directly the "permissible" prices for various fuels.

The horizontal lines represent prices for fuels; the vertical lines, costs per million B.t.u. of heat energy; the diagonal lines are the plotted heat unit values of fuels. The chart is read by converting the price of a given fuel (horizontal line), at its intersection with the diagonal line of the heat unit value of the fuel in question, to the vertical intersecting line which, read at the bottom of the chart, indicates the cost per million B.t.u., or *vice versa*.

To illustrate: For a comparison of 12,000 B.t.u. coal at \$5 per ton with fuel oil. Reading from the left scale, the horizontal line from \$5 per ton is followed to its intersection with the diagonal value line for 12,000 B.t.u. coal, then vertically down to the scale at the bottom of the chart, which indicates a cost of approximately 21c. per million B.t.u. The same vertical line is followed to its intersection with the diagonal value line for fuel oil, then horizontally to the scale on the right of the chart, which indicates a price of approximately 3c. per gal., at which such fuel oil would have to be procured to equal on a heat unit cost basis 12,000 B.t.u. coal at \$5 per ton.

Reversing this process, if fuel oil should cost 8c. per gal., this horizontal line carried to its intersection with the fuel oil diagonal, then down to the bottom,

*Excerpts from a pamphlet, copyrighted 1921, by W. S. Rockwell Co.

indicates a cost of approximately 56c. per million B.t.u. This same vertical line carried to its intersection with the 12,000 B.t.u. coal diagonal, then horizontally to the left, indicates a comparative price for coal of \$13.50 per ton. Direct comparisons are thus available between the coal and fuel oil prices; indicating that fuel oil would have to be available at 3c. per gal. to equal in heat unit cost 12,000 B.t.u. coal at \$5 per ton; and that if fuel oil cost 8c. per gal., 12,000 B.t.u. coal would be no higher in B.t.u. cost at \$13.50 per ton.

This method of comparison takes into account the cost per million B.t.u. merely as an intermediate step. If desired, fuel prices may be compared directly. For example, following along the horizontal line of \$5 per ton coal to its intersection with the diagonal 12,000 B.t.u. coal value line, then vertically down to the intersecting diagonal line for fuel oil, then horizontally to the right, reading directly the comparative price of 3c. per gal. for fuel oil.

At an assumed cost per million B.t.u., the "permissible" prices for the various fuels to be considered will be found by following the vertical "cost per million B.t.u." line to its intersection with each of the fuels in question, then to the right or left respectively to read the "cents per gallon" for a liquid fuel, the "dollars per ton" for a solid fuel, or the "cents per thousand cubic feet" for a gaseous fuel.

HEATING VALUE OF GASEOUS FUEL

If mass generation of heat is considered without reference to its nature or use, then the B.t.u. cost of

fuel would be the factor determining the choice. In addition there must be considered the chemical composition of the gas and of the mixture of gas and air supplied for combustion, and also the influence of the design of furnace or other appliance employed for the generation, application and utilization of the heat.

The chemical composition of a gas fixes the volume of air required for combustion, and the mixture so formed, from which the heat is released, has a B.t.u. value per unit of volume much less than that of the original gas itself. The quantity of air required for combustion of the various gases fluctuates greatly, being more for the richer gases and in general less with the decrease in B.t.u. value.

The heat unit value of the usual industrial gases may vary from 100 to 1,500 B.t.u. per cu.ft.; the theoretical quantity of air required for combustion may vary from 1 to 12 cu.ft. per cu.ft. of gas; the B.t.u. value of the combustible mixtures of these same gases, with the theoretical quantity of air required for combustion, may vary from 50 to 115 B.t.u. per cu.ft., or less with an increase in the relative quantity of air supplied. See Table I.

The B.t.u. value of a gas or its combustible mixture does not indicate the temperature obtainable by combustion or determine its field of usefulness.

Natural gas at 900 B.t.u., while apparently three times as rich as water gas at 300 B.t.u. per cu.ft., has a lower flame temperature and rate of flame propagation. Natural gas would not be as suitable as water gas for high-temperature blow-pipe operations such as

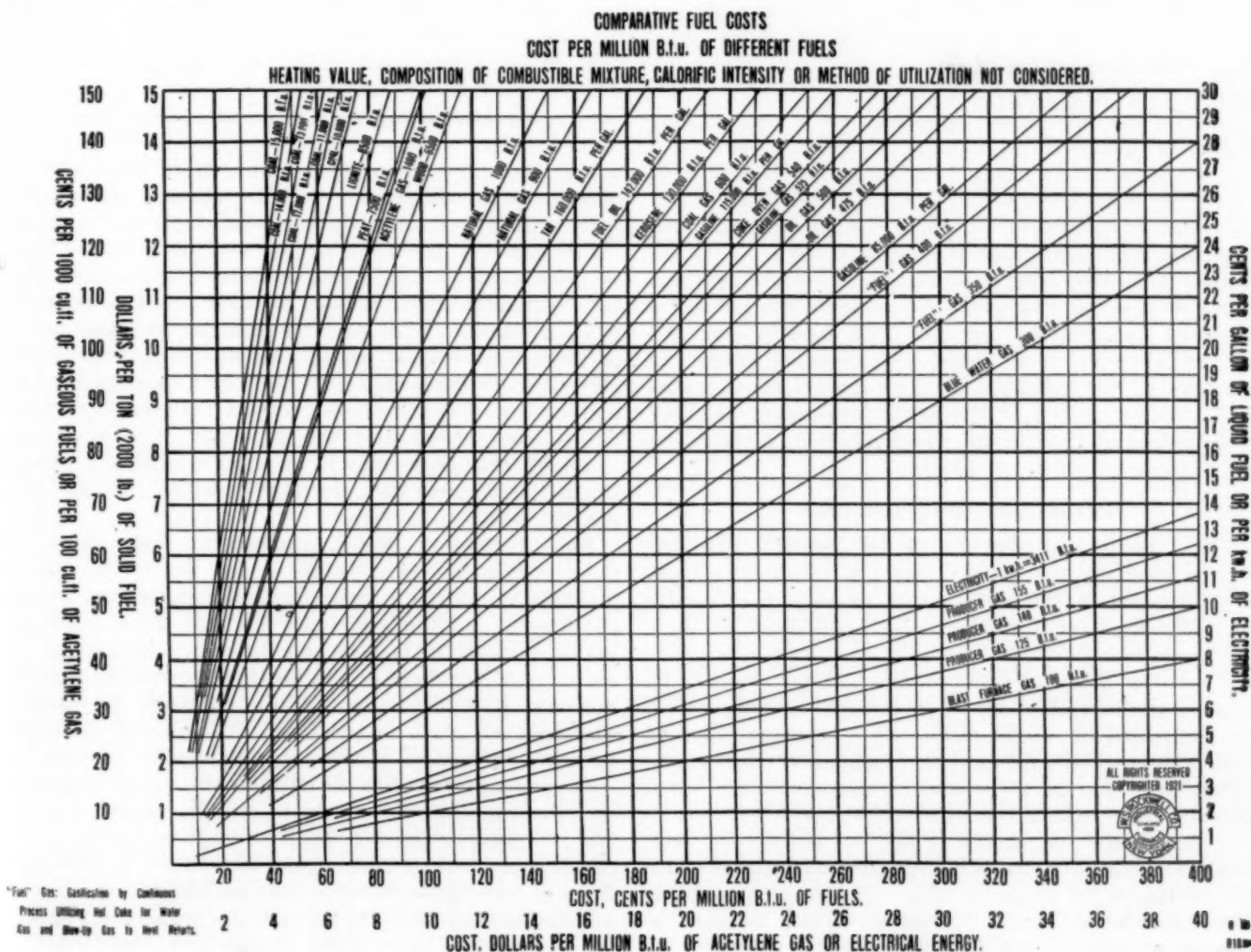


TABLE I. CHARACTERISTICS OF VARIOUS INDUSTRIAL GASES

	Acetylene	Natural Gas	Coal or City Gas	Coke-Oven Gas	Carburetted Water Gas	Oil Producer Gas*	Fuel Gas†	Water Gas	Producer Gas	Blast Furnace Gas
B.t.u. per cu.ft.	1,470	960	600	550	580	450	380	300	130	160
Chemical composition:										
Hydrogen, H ₂		3	41	53	38	1	48	46	12	3
Methane, CH ₄		92	30	35	10	10	12	2	1	1
Acetylene, C ₂ H ₂	96									
Ethylene, C ₂ H ₄		3	5	2	13	19	1			
Illuminants			3		3	1				
Carbon monoxide, CO			16	6	30	4	32	43	25	25
Carbon dioxide, CO ₂			2	2	3	6	3	5	6	13
Oxygen, O ₂	1		1		1	1	1	1	1	1
Nitrogen, N ₂	3	2	2	2	2	58	3	3	55	57
Volumes of air required for complete combustion	12	9.8	5.7	5.3	5.2	4.9	3.4	2.4	1.8	1.3
Maximum temperature obtainable, deg. F.	4,200	3,300	3,500	3,400	3,600	3,300	3,500	3,600	2,800	2,500
Maximum temperature with 100 per cent excess air	2,600	2,100	2,200	2,200	2,300	2,100	2,300	2,400	2,000	1,900
B.t.u. per cu.ft. of above mixture	59	47	48	48	50	47	49	50	41	41

* Oil gas made with air in internally fired retort or generator. † Gasification by continuous process, using hot coke for water gas, and blow-up gas to heat retorts.

welding. On the other hand, natural gas is preferable in internal combustion engines, in which the air and gas are mixed under heavy compression.

Producer gas, in its washed state, while suitable for gas engines, is not as well suited as water gas for high-temperature operations, such as forging or welding, yet with regenerative furnaces it is extensively used for melting steel. The design and operation of the furnace favor a field of usefulness which is not disclosed by an analysis of the gas itself. Both the gas and the air required for its combustion may be preheated to a high temperature in such regenerative furnaces, whereas if natural gas were employed in the same furnaces the preheating would be limited to the air alone, because the natural gas, by reason of its chemical composition, would dissociate in the regenerative chambers at such high temperatures.

The distribution of natural gas is frequently affected in cold weather by the formation of solids in the pipe lines. The distribution of carburetted water gas under similar conditions frequently results in the deposition of oil in the pipe lines resulting from condensation of certain hydrocarbons peculiar to this gas. Producer gas, while relatively cheap and less susceptible to such conditions in transportation, is not suitable for general distribution by reason of its low heating value and unusually high percentage of incombustibles.

Many examples from everyday practice with various forms of fuel could be given to illustrate the point not generally appreciated, that the difference in composition or "chemical form value" of industrial gases, the influence of the quantity of air supplied for combustion, and the design of the appliance, denote fields of usefulness and limitations which are not revealed by the customary B.t.u. comparison.

IMPORTANCE OF COMPOSITION

The fundamental significance of chemical composition as affecting the quality and cost of product must be considered in the selection of gases and of equipment for the transformation and application of their energy values.

When the material difference in B.t.u. value of the common industrial gases is considered together with the comparatively slight difference in heating value of their combustible mixtures, it is apparent that chemical composition is of greater importance than B.t.u. value in determining their field of usefulness.

The quantity of inerts or incombustibles is relatively small in the majority of industrial gases, with the exception of producer gas. The inert content is important in so far as it relates to the increase in volume of gas or combustible mixture necessary to furnish a given amount of heat energy, and to the

nature and cost of equipment and operations necessary for manufacture and distribution; but it is apparent from comparison of the inert content of the combustible mixtures of the different gases that the heating value of the gases is determined more by the elements forming the combustibles than by the percentage of inerts in the gases or in their combustible mixtures.

Consideration of the comparatively large volume of products of combustion of each gas, which are heated to the maximum temperature of the heating process, will indicate the economies attainable through efficient utilization of the spent gases to perform useful work. The heat in these gases may be utilized to preheat the air or fuel prior to combustion, or, as is generally more desirable, to preheat the material before it is exposed to the final working temperature.

The composition of the products of combustion must be considered in relation to its influence upon the product, because furnace atmosphere plays an important part in some processes which may require either reducing, neutral or oxidizing conditions. Frequently the apparent advantages of a comparatively cheap fuel may be offset by the chemical action of the resultant gases upon the process or apparatus, which would necessitate modifications in the furnace design or process in order to retain the advantage that may be represented by the form or price of such fuel. This is illustrated by the practices of employing crucibles for melting certain metals to decrease the possible effect of oxidation; of packing material in sealed boxes or pots; and by the muffle type of furnace employed for vitreous enameling; in each case permitting the application of heat without contact between the material to be heated and the products of combustion. Special atmospheres may be secured in muffles by passing suitable gases into the muffle, which may or may not be sealed.

Such limitation is not confined to fuels alone, as it is frequently encountered in the arc of resistance methods of releasing heat from electricity due to the gasification of the electrodes or resistance material. In most cases it is desirable to maintain neutral or reducing atmosphere in the heating zone to protect the material from oxidation. While this may be readily accomplished with most fuels in properly designed furnaces by control of the air supplied for combustion, it is comparatively difficult with others. Such a neutral or reducing atmosphere may be readily secured in electric furnaces releasing heat through some form of carbonaceous resistance material, while a different form of resistance material may necessitate the use of a material such as oil to provide the proper atmosphere in the heating zone, even though the heat itself is generated by an electrical process.

Electrically Heated Glass-Annealing Lehrs

By E. F. COLLINS*

THE accurate degree of temperature control through a cycle of temperatures which is necessary in annealing glass and the difficulty of securing it in the ordinary fuel-fired lehr have led to experiments with a view to developing electrically heated lehrs. One such lehr which has been running several months on a high grade of glass ware and on which reliable overall factory costs have been kept shows a decrease in cost per unit annealed of 20 per cent. This saving is about seventy-five times the total cost of power for heating the lehr.

Generally speaking, the annealing temperature for glass is that constant and uniform temperature at which any stresses which exist in the ware are permitted to relax. The length of the anneal, of "annealing time," depends on the magnitude of the stresses existing before annealing occurs, being a function of each point within the necessary temperature range.

In all glass annealing it is of vital importance that the temperature of the glass mass should be very uniform in the annealing range. Temperature gradients in the mass of homogeneous glass under treatment are solely responsible for setting up strains. These gradients may result either from too rapid cooling, or from a non-uniform and uneven heat distribution. Hence the importance of heat control with respect to time and also proper heat distribution in the lehr through which the ware is passing.

Where glass is treated in the box type oven it is also extremely important that the distribution be good and that the heating equipment lend itself to the exact following of the time-temperature cycle desired, whether it covers a few hours—or a month. Preferably this control should be automatic and correspond to a predetermined cycle. It is for this reason that electrically heated lehrs are successful.

Such automatic control with limits of plus or minus 2.5 deg. C. is available if electrically heated lehrs of proper design are used.

An example of temperature distribution in an electric furnace is given in Fig. 1, with its accompanying table.

*General Electric Co.

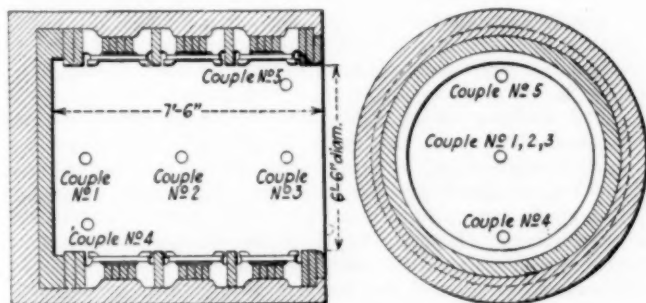


FIG. 1. TEST DATA OF HEAT UNIFORMITY OF ELECTRIC FURNACE

Time	Thermocouples—Temp. °C.					Average Temperature	Per Cent Deviation From Average	Rate of Change, Deg. per Hr.
	1	2	3	4	5		Above	Below
11.30	25	25	25	25	25	25	0	0
3.30	527	537	532	530	545	534	2.07	1.31
7.30	670	679	671	666	669	669	1.05	0.45
11.30	777	783	776	766	780	776	1.00	1.03
3.30	858	864	857	849	864	860	0.46	1.03
7.30	860	865	862	862	863	862	0.35	0.23
11.30	928	934	930	930	928	930	0.43	0.21
3.30	933	932	927	925	927	929	0.64	0.43
4.30	950	950	952	952	955	952	0.31	0.21

It will be noted on this record of temperature distribution that for a rising temperature of 125 deg. C. per hour over the first four hours only one point varies from the mean temperature by 2.07 per cent. Over the next four hours, with 35 deg. C. change per hour, the maximum variation from mean temperature is 1.5 per cent. The maximum at the rate of 17 deg. C. per hour is 0.43 per cent, while at constant temperatures, at 860 deg. C. the variation is 0.35 per cent, and at 930 deg. C. 0.64 per cent. These figures are for an oven 6 ft. 6 in. in diameter, and 7 ft. 6 in. deep. Such accuracy of control and evenness of heat distribution as these figures show would seem to meet the most exacting requirements of any and all types of glass annealing, including that of large lenses for telescopic work.

Fig. 2 is a graphic representation of the time temperature cycle for annealing fine crown glass for a telescope lens. Such process is best carried on in the

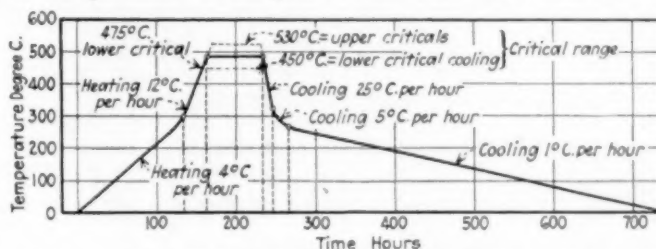


FIG. 2. TIME-TEMPERATURE CYCLE FOR ANNEALING CROWN GLASS LENS FOR TELESCOPE. BOX TYPE ANNEALING OVEN

box type of lehr in which the lens is placed and subjected to a temperature cycle as shown. With electric heat, automatic control is available by means of which this particular cycle or any similar one may be accurately followed and repeated exactly whenever desired. The control instrument is operated by a time-keeping motor supplemented by a simple cam arranged to give different rates of heating or cooling, according to the predetermined characteristic as shown on the curve.

Exact operating costs for electrically heated lehrs are not yet available, but from estimates made for such work it is believed that costs will be greatly in favor of the electrically heated lehr, especially when the improved quality of the product, increased production and elimination of rejects are taken into account.

The factors that assist in turning out better products are, first, there is no opportunity for the ware to absorb the products of combustion, hence no sulphuring takes place, and the product has a bright, polished surface requiring no washing or cleansing. Second, the ware is sterile and absolutely clean, due to the heat, which is important for prescription ware, allowing medicinals to be sealed in as soon as the ware leaves the oven. Lastly, there is the low-temperature gradient, which eliminates breakage, distortion and products developing flaws under the tests given after annealing.

Philippine Sugar Exports

During the period from March 1 to April 15, this year, the Philippines exported 16,189,944 kilos of sugar worth \$2,044,018. Of this quantity 7,941,470 kilos was centrifugal valued at \$1,019,379. The rest was raw sugar amounting to 8,246,674 kilos, worth \$994,599. More than 6,000,000 kilos of the centrifugal sugar exported, worth approximately \$1,000,000, was sent directly from Manila to the United States.

Synopsis of Recent Chemical & Metallurgical Literature

Allotropic Varieties of Oxides.—A study of the conductivities of a certain number of metallic oxides such as CeO_2 , Cr_2O_3 , NiO , CuO , TiO_2 , Mn_2O_3 , MnO , SnO_2 , SnO , Fe_2O_3 , Fe_3O_4 , ZnO and CdO shows that these oxides act like electrolytes and carbon. Their conductivity is a function of temperature, the representative curve being parabolic. Some oxides show peculiarities which can be attributed to allotropic varieties of these oxides.

Miss S. Veil has made a study of the allotropic varieties of such oxides, with special reference to magnetic iron oxide and cadmium oxide, and presented the results of her work at the May 6, 1921, meeting of the French Academy of Sciences. (*Comptes rendus*, vol. 172, pp. 1405-1407.)

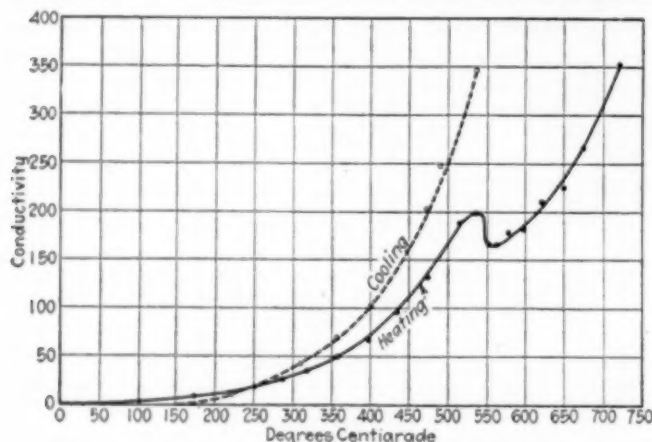


FIG. 1. REGION OF CURIE POINT FOR MAGNETIC IRON OXIDE

In studying magnetic iron oxide Miss Veil found that the conductivity-temperature curve presents a change of direction between 500 and 600 deg. C. (Fig. 1) and that this change corresponds to the Curie point, temperature at which the natural magnetite loses its magnetism. She has worked with temperatures varying up to 1,300 deg. C., but no other change of direction occurs after the Curie point. In cooling, the Curie point is not visible, and this indicates that the system does not pass through an analogous series of states when heated and when cooled. For the same temperature the conductivity is greater during cooling than during heating, as can be seen by the plotted curves.

The Curie point as fixed by Curie is 535 deg. C., whereas

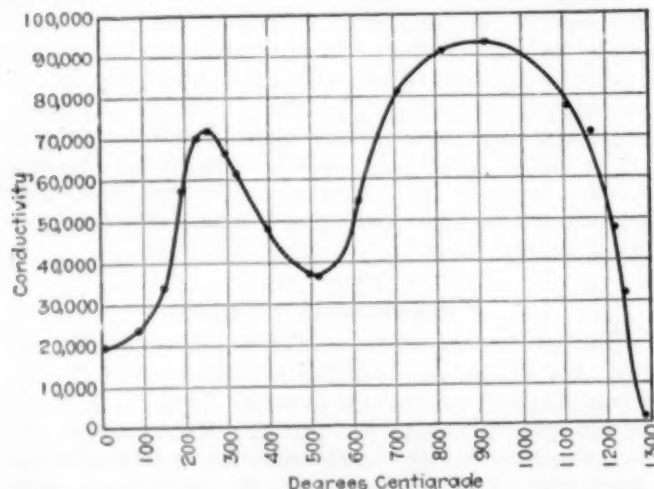


FIG. 2. CHANGE OF CONDUCTIVITY OF CADMIUM OXIDE WITH INCREASE IN TEMPERATURE

Weiss gives it as 580 deg. C. The first was determined by measuring the magnetic susceptibility, the second by the combination of magnetic and specific heat measurements. The Curie point as shown in the curve does not correspond exactly to either of these figures, this being due to hysteresis phenomena and to inherent irregularities in conductivity of oxide briquets.

Cadmium oxide has already an appreciable conductivity at ordinary temperatures (Fig. 2). An increase in temperature increases normally the conductivity, following a parabolic curve, up to about 200 deg. C., when the curve decreases up to about 550 deg. C., then increases again up to the second maximum, at about 850 deg. C., and finally decreases until at 1,300 deg. C. it reaches a conductivity which is only a small fraction of that at normal temperature.

These results can be interpreted by admitting that cadmium oxide presents three allotropic varieties of cadmium oxide—namely, α , β , and γ , whose stable regions are located on both sides of the maxima. Thus the region of the variety α is approximately between the ordinary temperature and 200 deg. C., that of the variety β between 200 and 850 deg. C., and finally that of γ at temperatures above 850 deg. C. The conductivity of the α and β varieties is about of the same order, whereas that of the γ variety is relatively very small.

In cooling rapidly, beginning at 1,300 deg. C., the conductivity remains very small, because the velocity of transformations is too small to take effect during rapid cooling, but if the cooling to normal temperature is slow and is realized only after many weeks, the oxide regains the variety α and shows the corresponding conductivity.

New Developments in the Manufacture of Tungsten and Its Compounds.—Moissan succeeded in melting tungsten in his electric furnace, but in extremely small quantities only and at the expenditure of considerable energy. Hugo Lohmann reports in *Electrochemisches Zeitung*, vol. 26, pp. 29-33, that he has been able to make comparatively large quantities of the crude metal and to obtain therefrom a thoroughly fused carbide in a specially designed furnace. The latter was of the arc type, but was constructed in such a manner that the principal disadvantages of this kind of furnace—viz., the smallness of the source of heat and the space within which it can prevail—are eliminated. It was possible to melt 5 kg., or 12 lb., of amorphous tungsten within fifteen minutes in this furnace. The current consumption is very low. Besides the carbide of tungsten, carbides of titanium, vanadium, zirconium, silicon, boron and uranium were obtained as well.

The hardness of tungstic carbide is 9.8 on Moh's scale. This substance was produced in large quantities and was used with great success to replace the industrial diamond, bort, in all its applications. By melting the carbide it was found that it could be produced in a strong, compact state so that it could be employed in making dies for wire-drawing machines, in fabricating cutting tools of all sorts, boring apparatus, etc. There appear to be important economic as well as technical advantages in favor of the carbide.

The melting of tungsten and the making of castings, forgings, etc., with the metal have rendered it usable for many purposes for which it could not be used hitherto. It was found that high-speed cutting tools made from tungsten gave very remarkable results in their durability and the thickness of the cut. Any tool or machine part that must stand up against extreme wear and exceedingly high temperatures caused by frictional resistance or otherwise has been improved very greatly by being made from the pure fused tungsten metal.

The author has prepared molten uranium at a temperature of 3,500 deg. C. in large quantities. He has used the metal in making the target in X-ray tubes and found that the results corroborated the theory that the higher the molecular weight of the target metal the more effective the X-ray apparatus. He also used the metal in making the contact points for the spark-plugs of gas engines, and instead of platinum for the contact wire in incandescent lights.

Current Events

in the Chemical and Metallurgical Industries

Investigation of the Dye Industry

Opponents of the special dye legislation have recently introduced resolutions in both branches of Congress calling for investigations of the dye industry. Some time ago Senator King of Utah presented a resolution requesting the appointment of a special committee to investigate the existence of a dye monopoly and its employment of lobbyists for the purpose of influencing tariff and other legislation. After this was referred to the Senate Committee on the Judiciary, that committee on July 12 reported a resolution similar in substance and intent, although the investigation was to be carried out by the Committee on the Judiciary or a sub-committee of it.

Congressman Frear, following his recent denunciation of the dye section of the Fordney tariff bill and his attack on the officials of the Chemical Foundation, introduced a resolution in the House requesting the Attorney General to instigate legal proceedings against the Chemical Foundation for its alleged fraudulent purchase, control and license of the patents obtained from the Alien Property Custodian.

Eugene Schneider Receives John Fritz Medal for 1922

With the presentation of the John Fritz Medal to Eugene Schneider, head of the famous Creusot Works, in Paris on Friday, July 8, by a mission of American engineers, came cable advices from London to the national headquarters of the American Society of Mechanical Engineers in this city announcing that more foreign honors had been conferred upon Americans distinguished in the engineering profession.

The cable message, addressed to Secretary Calvin W. Rice, stated that Ambrose Swasey of Cleveland, sponsor of the Engineering Foundation and past president of the American Society of Mechanical Engineers, has been elected to honorary membership in the British Institution of Mechanical Engineers, in the British Institution of Mining and Metallurgy and in the Institution of Mining Engineers.

Charles F. Rand of New York, it was stated, has been elected an honorary member of the Institution of Mining and Metallurgy and of the Institution of Mining Engineers. Mr. Rand, who is chairman of the executive board of the Engineering Foundation, has just been made an honorary member of the British Iron and Steel Institute.

Other elections announced by cable were those of Colonel Arthur S. Dwight of New York and William Kelly of Vulcan, Mich., to honorary membership in the Institution of Mining Engineers. This group of honors is believed to be without precedent in engineering and was described by Mr. Rice, who has been active in promoting closer relations between American and British engineers, as an important step in bringing about world solidarity in the engineering profession. A movement, it was said, has been started in the direction of federating the engineering societies of the British Empire according to the general plan adopted by Herbert Hoover and his associates in organizing the Federated American Engineering Societies, in which are gradually coalescing the national and local engineering organizations of the United States.

The ceremonies in Paris, participated in by a special deputation of thirteen American engineers under the general chairmanship of Mr. Swasey, followed similar ceremonies in London on June 29, when the John Fritz Medal for distinction in applied science was presented to Sir Robert Hadfield, known for his work in the development of manganese steel. The Hadfield award was for 1921 and the Schneider award for 1922. M. Schneider received the gold medal in person for his achievements during the war "in

the industrial and scientific defense of civilization."

The John Fritz Medal Board of Award, in conferring the honor, lauded M. Schneider's "achievement in the metallurgy of iron and steel, in the development of ordnance, especially the 75-mm. gun, and in notable patriotic contribution to the winning of the war."

Mr. Rand, it is said, becomes one of five honorary members of the Iron and Steel Institute, the others being the Prince of Wales, King Albert of Belgium and Dr. Richard Akerman and Baron Gustaf Tamm of Stockholm.

Chemical Exposition Plans

Plans to make the Seventh Annual Exposition of Chemical Industries the greatest in the history of the industry are progressing favorably. Being held during the week of Sept. 12, it will follow immediately the meeting of the American Chemical Society and the Society of Chemical Industry, and the sponsors of the display report more interest than ever, not only in the chemical industry itself but in the wide range of related industries.

Thus far more than 400 exhibitors will have places in the exposition, and before the books are closed Fred W. Payne, who, with Charles F. Roth, is managing the exposition, expects that last year's total of 457 will be exceeded. It is certain that every branch of chemistry will be represented and that the public will be introduced to many new and important phases of chemical development.

The 1921 display will present to the visitor a somewhat different aspect from its six predecessors. The Eighth Coast Artillery Armory can take care of all the exhibits on its one vast floor, comprising 180,000 sq. ft. Thus the appearance of the show will be much more impressive than it was staged on four floors of Grand Central Palace.

Technical sessions will be held in the auditorium, which is a solid brick, fireproof structure at one end of the building. Plans for these meetings include symposia on chemical engineering subjects: one on evaporating and drying, another on crushing, grinding and pulverizing and a third on material handling equipment. The following programs are only preliminary and details will be given in subsequent issues.

Papers on crushing, grinding and pulverizing include: "Ball and Pebble Milling for Pulverizing and Mixing," by H. F. Steinfeldt, of the Abbe Engineering Co.; "Grinding and Pulverizing With Air Separation," by S. B. Kanowitz, of Raymond Bros. Impact Pulverizer Co.

The following speakers are announced for the evaporating and drying symposium: E. G. Rippel, Buffalo Foundry & Machine Co.; A. E. Stacey, Jr., Carrier Engineering Corporation, "The Relation of Atmospheric Conditions to Chemical Processes"; H. S. Landell, Proctor & Schwartz, "Drying and Drying Problems"; Max Donauer, Elyria Enameled Products Co.; Arthur B. Stonex, Hunter Dry Kiln Co., "Drying With Moist Air"; A. S. Lissauer, W. L. Fleisher & Co., "Drying as an Air-Conditioning Problem"; J. D. Stein, Grinnell Co., Drier Division, "Atmospheric Drying by Means of Compartment, Tunnel and Continuous Belt Conveyor Driers With Some Practical Applications"; M. H. Dickerson, Atomized Products Co., "Spray Drying."

Motion pictures will also be shown in the auditorium. Films covering nearly every phase of the chemical industries have been promised. The following are representative: "Saving Wasted Millions Through Material-Handling Equipment," two reels (Courtesy of Economy Engineering Co.); "Conserving Coal and Saving Heat Values by Insulating Steam Pipe and Boilers," one reel (Courtesy of Pyrex Glass Association of America); "The Manufacture of Pyrex Glassware," three reels (Courtesy of Corning Glass Co.); "The Story of Sulphur," two reels (Courtesy of Texas Gulf Sulphur Co.)

American Electroplaters' Society Convention

Under the present industrial conditions it was very encouraging to find about 150 foremen electroplaters at the annual convention of the American Electroplaters' Society at Indianapolis, June 29 to July 2. The attendance was somewhat below normal, due in part at least to the failure of employers to pay the expense of their electroplaters, as many have done in former years. In times of industrial depression it is more important than ever to utilize opportunities for research and development, such as are to be gained from educational conventions; and manufacturers may well pay as an investment at least part of the expenses of their employees to such gatherings.

The large number of technical papers presented and the interesting discussions that ensued demonstrated that this organization is rapidly becoming a truly technical society and that through its efforts great progress has been and will be made in the electroplating industry. Several chemists interested in electroplating were present. The number should be increased to mutual advantage, as the chemists can often aid in the explanation of technical points and can at the same time become better acquainted with the platers and their point of view and thereby co-operate more effectively with them.

ELECTRO-ANALYSIS OF PLATING SOLUTIONS

It is significant that a number of the papers presented dealt with research problems and methods. Dr. Hiram S. Lukens, of the University of Pennsylvania, explained in detail various "Electrolytic Methods for the Determination of the Metal Content of Plating Solutions." Electro-analysis is an especially simple and appropriate method for persons engaged in electrodeposition. Emphasis was laid upon the fact that entirely satisfactory results may be obtained by the use of cathodes of copper or nickel, thus eliminating the expense for platinum. The various possible reactions occurring during electrodeposition and the advantage of control by chemical analysis were very clearly explained. The society, and especially the Philadelphia branch, are to be congratulated for securing the assistance and co-operation of Dr. Lukens, and the use for branch meetings of the laboratory at the University of Pennsylvania. Other educational institutions may well follow this example, as has been done by the University of Cincinnati and a few others.

ADDITION AGENTS IN ELECTRODEPOSITION

Dr. F. G. Mathers, of the University of Indiana, gave an interesting address upon the use of "Addition Agents in Electrodeposition," and showed a large number of specimens of lead, tin, antimony and silver deposited in the presence of specific addition agents. Dr. Mathers' paper emphasized the great possibilities in this field and especially the need for further research to explain the causes for the observed effects. Until such further knowledge is obtained, the general application of addition agents in electroplating will be rather limited. This field deserves extended investigation.

STRUCTURE OF BASE METAL AND ELECTRODEPOSIT

George B. Hogaboom, of the Scovill Manufacturing Company (and electroplating adviser to the Bureau of Standards), touched upon an almost entirely new subject when he explained the "Relation Between the Structure of the Base Metal and That of the Electrodeposit." He exhibited numerous photographs which showed clearly that some of the defects and difficulties encountered in electroplating are due not to improper composition of the solution or conditions of operation, but to defective structure of the brass, steel or cast iron upon which the metal was deposited. This subject is of far-reaching importance, as it emphasizes the fact that for successful electroplating the knowledge and services of the metallographist may be as important as those of the chemist and the plater. It is an all too common mistake to assume that electroplating can be used to cover or hide defective material or workmanship!

Several papers were presented upon nickel plating, among which may be mentioned those by R. Suman, of the National

Cash Register Co., and William Blum, of the Bureau of Standards, upon the use of fluorides. The latter paper summarized the work recently presented to the Electrochemical Society and also published in *CHEMICAL & METALLURGICAL ENGINEERING* (vol. 24, pp. 1109-1115, June 22, 1921). From the discussion that followed it appears that nickel solutions containing hydrofluoric or fluorides have been successfully used in several plants during the past year.

W. Blum and T. F. Slattery described the process for the electrolytic reproduction of engraved printing plates, recently installed at the Bureau of Engraving and Printing under the direction of the Bureau of Standards. In this process the printing surface consists of a heavy deposit of nickel (produced in solutions containing fluorides). The body of the plate, which is about 0.25 in. thick, consists of alternate layers of copper (each 0.003 in.) and nickel (each 0.001 in.). The use of such layers, first suggested and patented by George U. Rose, Jr., is advantageous in producing a stronger plate and in decreasing the treeing and thus permitting the use of higher current densities. Details of the process will be published in the near future.

W. Blum and M. R. Thompson, of the Bureau of Standards, presented a paper on the "Acidity of Nickel Plating Solutions," illustrated by experiments and charts. The meaning, measurement and expression of hydrogen ion in concentration were explained in simple terms, and the distinction between the degree of acidity and the amount of acid was emphasized. The use of indicators for the approximate measurement of the p_H of solutions was illustrated. The function of boric acid and of fluorides was shown to be in part that of "buffers"—i.e. regulators of acidity. Specimens of nickel deposited at definite p_H were exhibited.

In a paper by O. W. Storey, of the Burgess Laboratories, the use of methyl red for the factory control of the acidity of nickel solutions was described. This method, used by the author for the past eighteen months, illustrated admirably the practical applications of the principles described in the preceding paper.

COST ACCOUNTING

W. J. Allen, of Grand Rapids, in a paper upon "Cost Keeping in Electroplating" showed that it is entirely possible to determine approximate or average costs both in factory plating and in job plating. This subject is of special interest to engineers and manufacturers, as electroplating is often considered simply as a "necessary evil" and little thought is given to the relation between cost and quality or to the possibilities of real economies in operation.

PLANS FOR RESEARCH

A report was rendered upon the work and plans of the Bureau of Standards in the field of electrodeposition. The effort now being made by the National Research Council to obtain from interested manufacturers funds to augment research in electroplating was explained, and electroplaters were urged to assist in getting such support. All the papers upon the program emphasized the needs and possibilities for investigation in this fertile and important field, and manufacturers will no doubt take advantage of this opportunity for co-operative research.

The social features of the convention were very successful, and in spite of the hot weather all those present felt well repaid. The business sessions and elections were harmonious and showed the true spirit of co-operation. Few if any technical societies can point to as much real progress in less than ten years of existence as the American Electroplaters' Society.

Object to Tea Waste Duty

Objections are reaching Washington to the provision of the Fordney tariff bill which makes impure tea, tea waste, tea siftings or sweepings dutiable at 1c. per lb. The contention is that this important source of caffeine should be admitted free of duty.

While the Fordney bill advances the duty on caffeine itself from \$1 to \$1.50 per lb., it leaves unchanged the provision of the Underwood act which levies 1c. per lb. on the raw material from which caffeine is made.

Bureau of Mines Petroleum Experiment Station Seeks Technical Men

The Petroleum Experiment Station of the United States Bureau of Mines at Bartlesville, Okla., plans to enlarge its program of work and to employ a few additional technical men for conducting the different investigations. Funds for this work are provided by the State of Oklahoma, and for that reason it will not be necessary for applicants for the new positions to take civil service examinations. Persons interested should write H. H. Hill, superintendent Petroleum Experiment Station, Bartlesville, Okla., furnishing a statement of their education, experience and positions held and salary, together with a photograph taken within the past year.

The following is an outline of the positions open and the qualifications for each:

Petroleum Engineer for Work on Water Problems: Applicants for this position should be graduates from a college or university, with a degree in geology, or in mining, mechanical or civil engineering. The applicant should have had at least five years' oil-field experience, of which at least three years should have been on work connected with the development and production of petroleum. The applicant also should have had considerable experience in the solution and correction of water problems in producing oil and gas wells. Salary range \$3,000 to \$3,600 per annum.

Expert Driller: Applicants for this position should have had at least five years' actual drilling experience with cable tools; also experience in shutting off water by the use of mud-laden fluid and cement. Preference will be given to a man who has had supervisory work in connection with mudding, cementing and plugging of wells. Preference will also be given to a man who has had rotary drilling experience. Salary range \$3,000 to \$3,600 per annum.

Natural Gas Engineer: Applicants for this position should be graduates from a university or college with a degree in engineering, preferably mechanical engineering. At least five years' experience in work connected with the transmission of natural gas is required. This experience should include a knowledge of methods of metering natural gas, compressor stations and field equipment. Preference will be given to a man who is familiar with field conditions and who has had experience in the determination of pipe line losses. Salary range \$3,000 to \$3,600 per annum.

Assistant Petroleum Engineer: Applicants should be graduates of a college or university with a degree in geology or engineering. Applicants must have had at least one year's field experience in engineering work as applied to underground problems in oil fields. Salary range \$1,800 to \$2,400 per annum.

Co-operative Factory Investigation on Fish Scaling of Enamels

The committee on research and development of the Enamel Division of the American Ceramic Society is conducting a co-operative factory investigation of fish scaling based on the results of the Bureau of Standards research in this subject. The committee met at Cleveland, Ohio, on June 20, when a comprehensive study of this work on a factory scale was outlined. Steel and iron sheets will be prepared by the mills represented on the committee, and these will be manufactured into enameled ware in the enameling factories co-operating in the work. Some work will also be done by the enamellers in checking results obtained with enamel compositions and in annealing of enameled ware as developed at the bureau.

The preliminary report on the laboratory results as obtained by the bureau will be published in an early number of the *Journal of the American Ceramic Society*. The results of the co-operative work when completed will be combined with the laboratory results and issued later as a technologic paper.

The following members of the Enamel Division are serving on the committee:

R. R. Danielson, chairman, Bureau of Standards, Washington, D. C.; H. C. Arnold, A. D. Little Laboratory, Cambridge, Mass.; J. F. Bardush, Grand Rapids Refrigerator

Co., Grand Rapids, Mich.; J. S. Grainer, Challenge Refrigerator Co., Grand Haven, Mich.; D. M. Buck, American Sheet & Tin Plate Co., Pittsburgh, Pa.; J. A. Aupperle, American Rolling Mill Co., Middletown, Ohio; R. D. Cooke, Columbia Enameling & Stamping Co., Terre Haute, Ind.; J. B. Tyler, Lisk Mfg. Co., Canandaigua, N. Y.; E. P. Poste, ex-officio, Elyria Enameled Products Co., Elyria, Ohio.

Exchange of Wood Waste Through the Forest Products Laboratory

The Wood Waste Exchange of the U. S. Forest Service has been transferred from Washington to the Forest Products Laboratory, Madison, Wis., where its future activities will be centered. The Exchange has in the past contributed much toward more complete utilization of wood, by supplying a medium through which the mills and wood-using factories could locate markets for their side lumber and short lengths, and wood-consuming factories sources of material which would meet their requirements.

Centering the activities of the Exchange at the Forest Products Laboratory will permit an expansion of this service, in that it will be possible to include suggestions as to markets and new uses for byproducts and low-grade material, based on the latest results of technical research carried on by the laboratory. As both the Forest Products Laboratory and the Association of Wood Using Industries have pointed out, there is a large wastage of wood annually because of ignorance on the part of manufacturers of one another's wood requirements.

Quarterly reports on "Opportunities to Sell Waste," similar to those issued in the past, will be sent to all concerns which wish to be listed as having wood byproducts and waste in any form for sale. These reports will contain the names and addresses of manufacturers of various wooden products who could under suitable conditions use raw material from these sources, together with information as to kinds, sizes, form and condition of the stock desired. Suggestions as to the proper methods of caring for the material until it is ready for market will also be included.

A similar report on "Opportunities to Buy Wood Waste" will be sent to wood-using factories and other consumers who ask to be listed for this service. This report will contain information relating to manufacturers who have such material and its character, quality and amount available.

None other than actual producers or consumers of wood stock of this character can become patrons of this Exchange. All communications should be addressed to the Director, Forest Products Laboratory, Madison, Wis.

National Lime Association Urges Protection for Dye Industry

Although the lime industry is not directly interested in the dye industry, a careful analysis of the situation has convinced the members of the National Lime Association that the best interests of the country and those of the chemical and allied industries in particular demand the passage of protective legislation. Accordingly the following resolution was passed unanimously at the recent convention of the association and a copy was sent to each member of Congress.

Whereas a complete, self-sustained coal-tar chemical industry is essential to the industrial development of our country, to its national safety and security, and is important in its very close relation to medical science, and

Whereas it has been shown that unusual protection must be given by the Government to this industry, the development of which began only when the war gave it its opportunity, and that a tariff alone will not protect it adequately against the determined assaults of the German-government-fostered-chemical-cartel which is seeking to regain this, the world's richest market, now the only market without permanent protection; therefore, be it

Resolved, That the National Lime Association hereby urges upon Congress in solemn earnestness the prompt enactment of adequate legislation to protect and maintain in this country this vital chemical industry.

Ford Offers to Lease Wilson Dam and Buy Nitrate Plant

Henry Ford's offer to lease the Wilson Dam and to purchase the nitrate plant at Muscle Shoals promises to be disconcerting to some of the ultra-conservationists in Congress. They opposed Government development of the project both in bringing about the defeat of legislation looking to the formation of the United States Fixed Nitrogen Corporation and in refusing to appropriate for the continuance of the work on the Wilson Dam.

They are embarrassed greatly by Mr. Ford's offer. They fear that private enterprise will obtain the great bulk of the profits likely to come from the development of this resource. In defeating the proposals for Government operation of the Muscle Shoals projects Congress maneuvered itself into a position where it seems that it cannot refuse consistently to entertain a bona fide offer from a private interest. In doing so some of the conservationists fear the loss to the general public of the full advantages of one of their heritages.

Mr. Ford's offer is to lease for 100 years the completed Wilson Dam. On the total cost, Mr. Ford proposes to pay interest at the rate of 6 per cent. It is estimated that about \$28,000,000 will be required to complete the dam. He offers \$5,000,000 for the nitrate plant (No. 2), the steam plant, lands and other equipment.

Colonel Gilchrist Honored

A distinguished service medal has been awarded to Lieutenant Colonel Harry L. Gilchrist of the Chemical Warfare Service. The citation reads as follows:

Lieutenant Colonel Harry L. Gilchrist, Medical Corps, then Colonel, Medical Corps, for exceptionally meritorious and distinguished service as Chief of the De-lousing and Bathing Services of the American Expeditionary Forces. By his superior administration and splendid efficiency he contributed materially to the success achieved by the Army at the ports of Brest, Bordeaux and St. Nazaire, in the return to the United States of the American Expeditionary Forces.

Potash Duty Faces Hard Fight

It is very evident that great difficulty will be experienced in retaining the potash item in the tariff bill. Allegations that this duty will cost the farmers \$6,000,000 or more will be accepted by many members of Congress who represent large agricultural constituencies. Unusual interest is being taken in the matter by the representatives of the farmers, since most farmers have allowed their lands to become under-fertilized and have reached the point where they must make much larger purchases next year. To have anything interfere with possible decline in price brings forth loud complaint.

On the other hand, the representatives of the domestic potash producers point out that the duty in the form prescribed by the committee is not as satisfactory as a straight 50c. duty for which they contended. The duty as provided in the bill may take care of the plants in existence, but it certainly will not encourage any new capital to enter the industry. It also is pointed out that most of the schedules are much higher than they seem, since they are affected by the American valuations. This is not true in the case of any but chemical potash.

New Proving Ground Ready

Field tests of gases now can be carried forward rapidly by the Chemical Warfare Service. This is made possible by the making ready of the new proving ground adjacent to Edgewood Arsenal. This phase of the work of the Service has been interfered with greatly due to the fact that the proper equipment could not be installed at the Lakehurst proving ground when it was known that it was to be abandoned in the near future.

Since there is no uncertainty as to the tenure of the new proving ground, permanent facilities have been installed. These include machine shops, laboratories, field sampling outfits and the general equipment of an efficient proving

ground. In addition there is a light gage railroad which will make for great economy in the conduct of tests. There is the greatest need at the present time to be able to ascertain quickly and with exactness the concentrations of gas under conditions of actual use. General Fries believes that with the improved facilities of the new proving ground great headway will be made in that work. He admits, however, that there is great chance for improvement in the methods of ascertaining gas concentrations in the field. This problem is to be attacked vigorously by the technical men of the Service and it is hoped that valuable suggestions may be contributed by outside chemists.

Growth in French Porcelain Industry

At a recent meeting of the Syndicat des Fabricants de Produits Ceramiques de France, Paris, France, M. Guerineau, honorary president of the association, said that there has been a remarkable growth in the production of refractory materials in that country since the war. The output at the present time approximates 700,000 tons, which is said to be sufficient for all home needs; in 1914 the aggregate production was only 500,000 tons per annum. With regard to floor tile, M. Guerineau says that French producers are now in position to meet the entire home demand, which is quite considerable, including pavement and floor tiles, whether semi-opaque or incrustated. Local manufacturers of enameled tiles for walls, although few in number, are in good position to furnish all requirements of French consumers.

C.W.S. Course Completed

A class of twenty-two was graduated July 9 at the Chemical Warfare Service School. Among those graduated were three students sent to the school by the Navy and three sent by the Marine Corps. Lieutenant Commander J. McC. Miller, one of the Navy men, stood at the head of the class. The graduating class was addressed by General Fries and Major Atkisson.

A number of line officers are expected to be members of the next class. Those graduated July 9 were:

Majors Adelno Gibson, C.W.S.; Charles W. Mason, C.W.S. Captains Maurice Barker, C.A.C.; Arthur A. Dearing, C.W.S.; Egmont F. Koenig, C.W.S.; Edward C. McLaughlin, C.W.S.; Hiram F. Plummer, C.W.S.; James W. Rice, C.W.S.; Adrian St. John, C.W.S.; Edmund G. Sties, C.W.S.; Edward Wolesensky.

First Lieutenants John W. Lowe, John G. Shannonhouse, James F. Smith and Alden H. Waitt.

From the Navy: Lieutenant Commanders Glenn B. Davis, U. S. N.; Norman C. Gillette, U. S. N.; Justin McC. Miller, U. S. N. and Lieutenant Charles Shaffer, M. C. (U. S. N.)

From the Marine Corps: Captain Ernest E. Eiler, First Lieutenant John W. McNamara, Second Lieutenant Leslie G. Wellman.

Carbonization Committee Meets

The carbonization committee of the American Gas Association met on July 6 to make final plans for the annual report in the fall. It is planned that the manufacturers' group on this committee will summarize all new methods of carbonization of interest to the gas industry by brief descriptions of the plant and processes. The operating sub-committee will report upon as many plants as can be investigated carefully, showing typical operating results for new plant developments. The low-temperature carbonization sub-committee will give similar attention to methods, results and general prospects for low-temperature carbonization of coal. Particularly it is hoped to have consideration given to the economic possibilities of such systems and a discussion of the place which they will fill in the general fuels work of the country.

J. H. Taussig of the United Gas Improvement Co., Philadelphia, is general chairman. The sub-committee chairmen are: Manufacturers sub-committee, F. G. Curfman, Improved Equipment Co., New York City; operating sub-committee, W. H. Earle, Rochester Gas & Electric Corporation, Rochester, N. Y., and low-temperature carbonization sub-committee, J. D. Davis, Bureau of Mines, Pittsburgh.

Industrial Gas Mask for Ammonia Approved

The first approval of an industrial gas mask for use in ammonia fumes has been issued by the United States Bureau of Mines to the Mine Safety Appliances Co., of Pittsburgh, Pa. The Burrell ammonia mask successfully passed the exhaustive series of tests given by the bureau's chemists in accordance with Schedule 14, "Procedure for establishing a list of permissible gas masks."

The gas mask used during the war by the United States Army was largely developed under the direction of the Bureau of Mines and the Chemical Warfare Service. Since the war the Bureau of Mines has been engaged in adapting and developing the gas mask for industrial purposes and promoting its safe usage.

The Burrell ammonia mask consists of an Akron type, Tissot facepiece that allows breathing through the nose, fitted with a special ammonia canister containing copper sulphate pumice stone mixture devised by G. St. J. Perrott, Max Yablick and A. C. Fieldner for the Ordnance Department of the United States Army. It has been found to give absolute protection in any percentage of ammonia gas which the wearer of a mask can stand without unbearable skin irritation.

The canisters submitted by the Mine Safety Appliances Co. protected successfully against 3 per cent of ammonia at a breathing rate of 64 liters per minute for a period of five minutes. This represents the maximum concentration that anyone is likely to enter, as it has a very strong action on the skin. In a concentration of 2 per cent ammonia and a breathing rate of 32 liters per minute, corresponding to active work, six canisters gave a service period of thirty to forty-one minutes. The requirement for approval is twenty minutes.

Special tests of the facepieces fitted with special canisters were made in 1 per cent of sulphur dioxide gas in air, since sulphur dioxide gives a more severe test for facepiece leakage than ammonia.

Approval 1,401 issued to cover this mask states that the mask is approved for safety, practicability and efficiency in concentrations of ammonia in air not exceeding 3 per cent for short periods of time, as ten minutes, or for periods of twenty to thirty minutes in air not exceeding 2 per cent ammonia, and for proportionately longer periods of time in lower concentrations. The replaceable canisters were approved for use only with approved facepieces and harness.

Permissible ammonia masks under this approval will hereafter bear a plate with the seal of the Bureau of Mines, approval and caution clause to promote safe usage.

Patent Policy of the War Department

Announcement is made that it is the policy of the War Department to encourage the development of military inventions by officers, enlisted men and civil employees. In consideration of assistance to be given by the department in the issue of patents, it will require of inventors no more than a license to manufacture and use their inventions for governmental purposes, thereby reserving to the patentee complete freedom and ownership of the patent in its commercial applications. In special cases of inventions of great military importance, however, provision is made for exclusive Government ownership and the utmost secrecy.

Personal

CHARLES Y. CLAYTON, professor of metallurgy at the Missouri School of Mines, will be at Dr. Howe's laboratory at Bedford Hills, N. Y., during the summer.

Dr. HARRY A. CURTIS, who has been with the International Coal Products Corporation as chief chemist, is now general manager of one of the subsidiaries of this company known as the Clinchfield Carbocoal Corporation, South Clinchfield, Va. In this capacity he will have charge of

the plant and industrial village owned by the corporation and be responsible for the further development and operation of the carbonization plant.

EDWARD A. DIETERLE, who has been assistant chief chemist of the Koppers Co., Pittsburgh, will be the chief chemist of the Chicago By-Product Coke Co. The latter plant will be in operation about Sept. 1 to supply mixed coke-oven and water-gas to the Peoples Gas, Light & Coke Co., as a portion of its city supply.

MARTIN G. GEIGER, Harrisburg, Pa., has become connected with the Klipstein Chemical Co., Charleston, W. Va., as chemical engineer.

M. R. HULL, designing engineer of the Chile Exploration Co., has returned from a three months' trip to the company's South American properties.

Colonel JOHN W. JOYES has been chosen to head the technical division of the Ordnance Department of the Army. Colonel Joyes was prominently associated with the nitrate work of the War Department during the war. Recently he has been head of the artillery division of ordnance. He succeeds Colonel C. L. H. Ruggles, who has been instructed to take the Army War College course.

JULIUS KLEIN, who was appointed by the President as Director of the Bureau of Foreign and Domestic Commerce, to fill the position made vacant some time ago by the resignation of R. S. MacElwee, has assumed his duties. Dr. Klein first came to the bureau in September, 1917, as chief of the Latin American Division. He remained in that capacity until May, 1919, when he was made commercial attaché of the department at Buenos Aires, Argentina. He resigned from that position in October, 1920.

CHARLES V. MCINTIRE has resigned his position as chief engineer of the International Coal Products Corporation to enter the field of consulting engineering in association with A. Stephen Knowles of New York City. Mr. McIntire will specialize in the preparation and treatment of coal.

W. W. ODELL, fuels engineer of the Bureau of Mines, is now in North Dakota, where he will co-operate with Prof. Babcock of the University of North Dakota on an extended series of tests of lignite carbonization. The experimental work will be done in the small lignite coking plant of the university as a portion of the co-operative work of the Bureau of Mines and the university.

Dr. J. H. SHRADER, formerly of the United States Department of Agriculture, Washington, D. C., has been appointed Director of the Bureau of Chemistry and Food, Health Department, Baltimore, Md., entering upon his duties July 1.

WALLACE F. SUPER has been transferred from the Laurel Hill, L. I., to the Syracuse plant of the Atmospheric Nitrogen Corporation.

Dr. ROSCOE THATCHER, who succeeds Dr. W. H. Jordan as director of the New York State Agricultural Experiment Station, located at Geneva, assumed his duties July 1.

N. JULIEN THOMPSON has left the employ of the State of Connecticut Industrial Waste Commission and will be retained by the Standard Rolling Mills Co. of Springdale, Conn., as engineer, in charge of development work on a byproduct lithopone plant.

The annual meeting and election of officers of the American Institute of Fertilizer Chemists was held at Battery Park Hotel, Asheville, N. C., on June 24, and the following officers were elected for the ensuing year: President, Dr. Frank L. Parker, of Charleston, S. C.; vice-president, A. G. Stillwell, of New York City; treasurer, W. J. Gascoyne, Jr., of Baltimore, Md.; secretary, S. W. Wiley, of Baltimore, Md.

Obituary

Dr. WALLACE CALVIN ABBOTT, founder and for more than thirty years president of the Abbott Alkaloidal Co., now known as the Abbott Laboratories, died at his home in Chicago, July 4.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 15, 1921.

Chemical inquiries increased in certain products during the week and in these lines the volume of business improved. In other directions trading was slow and the market activity was in specialties. It might be described as steady on the average yet devoid of unusual propelling features and free from any radical developments. While there are some contracts being placed for future business, most of the buying is for immediate consumption. Consumers are still afraid that prices have not touched bottom in the more important items regardless of stability of values in several of the big basic chemicals. Any rise in prevailing quotations would attract keen attention, but it may be some time before there is enough confidence in values to inspire free buying for prompt and forward shipments.

CONSERVATIVE TRADING THE RULE

There are so many conflicting interests at work at present that conservative trading seems to be the only method of operating. The drastic decline of values in the past eight months has prompted caution all around. Resistance to selling pressure is more pronounced at present and there are no more signs of forced liquidation. Fundamentally, the market is in a much better condition than it was at the beginning of the year, but the proposed revision of import duties is not inspiring to large business temporarily and the ebb and flow of small orders is to be expected. The steady influx of imported chemicals at prices below those named for domestic goods is a restraining influence on American outlet, but the producers are convinced that this condition will right itself when once the new tariff law becomes effective.

GENERAL CHEMICALS

One of the large chemicals which evoked keen interest during the past few days was *bleaching powder*. Prominent manufacturers of this chemical state that they have received numerous inquiries and have booked several large orders for shipment from works to paper mills. The settlement of the recent strike in paper plants has permitted mills to resume operations and there was an immediate response in the call for bleach. Another item that attracted considerable attention was the offering of German *caustic soda* at \$3.35 per 100 lb., duty paid. Domestic caustic soda has displayed its recent stability on spot. Dealers quote the market on 88-92 per cent *caustic potash* at 5@5½c. per lb., while rumors are current that some business has gone through below the inside figure. Some of the largest distributors say they cannot sell this material under 5½c. per lb. Moderate trading is reported for soap-making requirements, but the general demand is rather slow at present. The opinion is prevalent that prices in this commodity are quite near rock bottom. Small sales of *permanganate of potash*, U.S.P., were reported at 29@30c. per lb., depending upon quantity. Moderate inquiries have recently reached the market for limited lots and sellers have not experienced much difficulty in obtaining the above prices. This product was selling at \$4 per lb. during the war. Prominent sellers of *acetate of soda* quote the market at 4½c. per lb. inside and the general quotation is 4½@4½c., depending on quantity. The demand has not shown very much activity during the past few days and the call has been chiefly restricted to small lots for actual requirements. Large factors in *bichromate of soda* quote the market at 8@8½c. per lb. Resale material has changed hands at 8@8½c. per lb., according to seller. In most quarters where resale material is handled it is stated that the market looks as though it was thoroughly liquidated. Dealers report sales of standard brands *caustic soda* at \$4@4.10 per 100 lb., while scattered transactions for export have been made at \$4.15@4.25 per 100 lb. At the works, resale material was quoted at 3½@4c. per lb., depending upon seller, the inside figure

being for large lots. The contract price is quoted at 3½c. per lb. basis 60 per cent, f.o.b. works. It was stated that a 100-ton order of German caustic soda was recently booked at \$3.35 per 100 lb. Sales of *chlorate of soda* are reported by prominent factors on the basis of 7½c. per lb. f.o.b. works for prompt shipment. This price is about as low as can be quoted in any direction. There is not much activity to report on *nitrate of soda* and sellers quote 7½@7½c. per lb. for spot material. Some interests are above these prices, but odd lots are on the market and buyers seem to be interested only in quotations that are on the spot market for immediate requirements. Spot prices for imported *prussiate of soda* were a shade easier and sellers quoted 12@12½c. per lb. The demand for this chemical has not been pronounced during the past week and some sellers have resorted to price shading in an attempt to stimulate business. Quiet trading continues to feature the market on powdered *white arsenic* and sellers state that only odd lots are moving at the present time. Prices range from 6½@7c. per lb. *Red arsenic* is quoted by producers at figures ranging from 12@13c. per lb., according to quantity.

COMPARATIVE LIST OF CHEMICALS DURING MONTH OF JUNE, 1921

Product	High	Low	Close
Acetate of soda, lb.....	\$0.04½	\$0.04½	\$0.04½
Arsenic, lb.....	.07	.06½	.06½
Bicarbonate of soda, lb.....	.02½	.02½	.02½
Bichromate of soda, lb.....	.08½	.08	.08
Bleaching power, lb.....	.02½	.02½	.02½
Carbonate of potash, 80-85%, lb.....	.06	.05	.05
Caustic potash, 88-92%, lb.....	.05½	.05	.05
Caustic soda, lb.....	.04½	.04	4.10-100 lb.
Citric acid, lb.....	.46	.44	.44
Formaldehyde, lb.....	.14½	.13	.13½
Muriate of potash, ton.....	50.00	45.00	48.00
Oxalic acid, lb.....	.20	.18	.18
Permanganate of potash, U. S. P., lb.....	.32	.30	.30
Soda ash, 100 lb.....	2.20	2.00	2.10
Sulphide of soda, 60-62%, lb.....	.05½	.05½	.05½
Tartaric acid, lb.....	.30	.28	.29

COAL-TAR PRODUCTS

Producers and sellers in general have little in the way of new developments to report. The consuming demand is irregular, but it is believed that the inquiries in the market show a need of supplies and by going after these business can be done in a small way in domestic quarters. The export business shows little signs of a revival except for benzene. Imports of coal-tar products for the month of May, 1921, amounted to \$401,837, for the corresponding month of 1920, \$634,840. For eleven months ended May, 1921, the total was \$13,732,176, just double that of the corresponding period of 1920, which was \$6,464,047. There were no imports of benzene during the month of May in either 1920 or 1921, but the exports in May, 1921, amounted to 18,102,679 lb., valued at \$788,511, and for May, 1920, 1,483,096 lb., valued at \$97,775. The imports of naphthalene for eleven months ended May, 1920, amounted to 5,358,800 lb., valued at \$139,936, while for the corresponding period of 1921 they amounted to 13,456,830 lb., valued at \$502,490. In comparing the month of May, 1920, with May, 1921, there seems to be about 600,000 lb. less imported this year. Besides the exports of benzene there were other coal-tar distillates valued at \$856,976 in May, 1920, and \$21,228 in May, 1921.

Sellers report a better inquiry, and sales while taking place only in small quantities, are embodying a wider variety of products. Cheap resale lots are fast disappearing from the market. *Benzene* is moving quite steadily and prices are firm at 27@30c. per gal. for the pure and 25@28c. per gal. for the 90 per cent grade. *Naphthalene* is in easy supply, but there is only a little demand noted and prices range from 7@8½c. per lb. In some quarters a fair routine movement is noted in *phenol* with the inside figure heard at 9½c. per lb. Intermediates are gradually picking up and while the demand is confined to small lots, it is nevertheless spreading throughout the list and prices are more steady. *Beta naphthol* continued quiet with the low figure named at 35c. per lb. in some directions. The general quotation ranges from 35@40c. per lb., depending on quantity. *Dimethylaniline* is a shade lower at 38@50c. per lb., depending upon seller. There is little other than a routine movement in *paranitraniline* and prices range from 82@90c.

per lb. Reports from some quarters on *para amidophenol* reflect a steady demand for the base material, and while \$1.50 per lb. is quoted by most sellers, some shading on a firm order is thought quite possible. The hydrochloride is quoted at \$1.60@1.75 per lb., but very little business is being done. The tone of the market in *aniline oil* is steady, although there is still only a small-lot movement of a routine nature. Prices range from 20@26c. per lb. with some producers reporting a limited business around 23c. The demand for *aniline salt* is quiet and only an irregular small quantity of business is reported. Consumers show few signs of coming into the market and prices are a shade lower at 25@28c. per lb.

HIGH AND LOW PRICES IN COAL-TAR PRODUCTS DURING JUNE, 1921

Products	High	Low
Benzene, c.p., gal.	\$0.27	\$0.27
Cresol, U.S.P., lb.	.16	.16
Cresylic acid, 97-99%, gal.	.75	.70
Naphthalene flakes, lb.	.08	.07
Phenol, lb.	.11	.10
Solent naphtha, water white gal.	.25	.25
Toluene, gal.	.28	.28
Benzoic acid, U.S.P., lb.	.65	.60
H acid, lb.	1.30	1.20
Naphthionic acid, crude, lb.	.75	.70
Salicylic acid, U.S.P., lb.	.23	.20
Sulphanilic acid, lb.	.32	.30
Alpha naphthylamine, lb.	.40	.35
Aniline oil, lb.	.23	.20
Aniline salt, lb.	.28	.26
Benzaldehyde, tech., lb.	.45	.45
Benzidine, base, lb.	1.00	.85
Beta naphthol, tech., lb.	.40	.38
Diethylaniline, lb.	1.30	1.20
Dimethylaniline, lb.	.45	.40
Diphenylamine, lb.	.60	.60
Monochlorobenzene, lb.	.14	.12
Nitrobenzene, lb.	.13	.12
Para nitraniline, lb.	1.00	.85

VEGETABLE OILS

Trading in *chinawood oil* was inactive and the undertone covering forward business was barely steady. For spot oil nominal quotations ranged from 14@15c. per lb. A quantity now afloat was offered at 11½c. per lb., c.i.f. New York. July shipment from the Orient closed at 10½@10¾c. per lb., c.i.f. New York. On the Coast 12c. was asked for spot oil in hardwood barrels. The demand for *coconut oil* was quiet and prices in some directions were hardly steady. Manila oil was offered at 7½c. per lb., bulk basis, July-August shipment, c.i.f. Coast, while for tank cars there were sellers at 7½c. per lb., forward shipments, f.o.b. Coast. Prompt shipment oil on the Coast held at 7½@8¼c. per lb., sellers' tanks. Domestic Ceylon type oil closed nominally at 8½@8¾c. per lb., sellers' tanks, f.o.b. New York. Advices from the Middle West reported a slightly firmer tone in the market for *crude corn oil*, in sympathy with the strength in cottonseed oil, but the actual price changes were very slight. The mills in the West were asking from 5½@5¾c. per lb., sellers' tanks, immediate shipment. With the advance in crude cottonseed, the market for *peanut oil* held firm. Oriental crude sold at 6¼c. per lb., Coast, sellers' tanks, prompt shipment. A sale of one carload of imported oil sold at 6¼c. per lb., sellers' tanks, f.o.b. Coast. Domestic oil sold at 7c. per lb., basis prime, f.o.b. mills, Southeast, with numerous bids in the market at 6¾c. Several holders of domestic crude raised their views to 7¼c. per lb., buyers' tanks, f.o.b. mill. A sale of *crude soya bean oil* went

HIGH, LOW AND CLOSE IN VEGETABLE OIL MARKET DURING JUNE, 1921

	High	Low	Close
Castor oil No. 1, U.S.P., lb.	\$0.10½	\$0.10	\$0.10½
Castor oil, tech., lb.	.09	.08½	.08½
Chinawood oil, coast, bbl.	.14	.12½	.13½
Chinawood oil, N. Y. bbl., lb.	.15	.13	.14
Cocanut oil, Ceylon, bbl., lb.	.10½	.10	.10½
Cocanut oil, Cochin, bbl., lb.	.11	.11	.11
Corn oil, crude, bbl., lb.	.07½	.07	.07½
Corn oil, refined, bbl., lb.	.09½	.09	.09½
Olive oil, denatured, bbl., lb.	1.45	1.35	1.35
Palm oil, lagos, bbl., lb.	.07½	.06½	.06½
Palm oil, Niger, bbl., lb.	.05½	.05	.05½
Peanut oil, domestic, f.o.b. mill, lb.	.06	.05½	.06
Peanut oil, deodorized, lb.	.10½	.10	.10½
Rapeseed oil, refined, bbl., lb.	.92	.88	.88
Soya bean oil, N. Y., bbl., lb.	.07½	.07	.07½

through late last week at a shade under 6c. per lb., sellers' tanks, duty free, immediate shipment from the Coast. The market closed nominally at 6@6¼c. per lb., Coast basis, tank cars. Importers now believe that there is a possibility for a resumption of trading in futures, owing to the upward tendency of cottonseed and other edible oils.

The Chicago Market

CHICAGO, July 15, 1921.

There were no new developments in the industrial chemical markets during the past two weeks. A fair volume of small orders was reported in most quarters and inquiries were fair, but no large transactions were noted. Dealers and agents seem to have ample supplies on hand and in general prices are firm with a few exceptions.

GENERAL CHEMICALS

Caustic soda is in a very firm position with supplies light. The ground or flake 76 per cent is quoted at \$4.65@4.75 per 100 lb. and the solid at \$4@4.10. *Soda ash* is moving very well and \$2.60 per 100 lb. for barrels was the best offer noted. *Sal ammoniac* is weaker with continued arrivals of foreign material, and supplies of the prime white granular are available at 7¼c. per lb. for large casks. There is a small demand for *barium chloride* and the white crystals are offered at \$75@85 per ton, according to the quantity. There was a somewhat better request for *powdered alum* and several sales were noted at 8@8¼c. per lb. *Carbon tetrachloride* is firm, with the inquiry good, holders asking 11@11½c. per lb. for the large drums. *Formaldehyde* is rather lifeless and little business was reported at the present level of 14c. per lb. in barrels.

The alcohol market is in a poor condition and little or no business is reported. A wide range of prices can be obtained on completely denatured and stocks in second hands are heavy. Distillers quote 35c. per gal. drum basis on No. 5 c.p. 188 deg. proof. *Methanol* is in a better condition and small orders were filled for the 95 per cent at 85c. per gal. in drums. *Glycerine* is weak, with the inquiry light, and ample supplies are available at 14¼c. per lb. for the large drums. The bichromate situation lacks new features and the prices are firm with only small quantities moving. *Bichromate of soda* is held at 9@9¼c. and *potassium bichromate* at 14c. per lb. *Caustic potash* is moving in a fair way at 6¾c. per lb. for the 88-92 per cent. *Nitrite of soda* is firm and unchanged at 9c. per lb. for single casks. *Hyposulphite of soda* is in good demand and holders are asking \$4.05 per 100 lb. for the pea crystals. *Zinc chloride* is steady and spot goods are offered at 11½c. per lb., although a somewhat better offer was noted on material for prompt shipment from the east. *Zinc sulphate* is quiet and supplies are available at 3¼c. per lb.

The list of acids is very quiet with few changes in prices reported. *Acetic acid*, 28 per cent, is moving in a fair way at \$2.60 per 100 lb. in barrels. The *glacial acid* is dead and prices range from 8@11c., according to the quantity and holder. *Oxalic acid* is in good demand and supplies are available at 18c. per lb. The heavy acids are unchanged as to price and are not moving so well. *Sulphuric acid* is still quoted at \$19@20 per ton in tank cars f.o.b. works.

VEGETABLE OILS

The only item worthy of attention in this market is *linseed oil*. This item is very firm and dealers report a fairly good movement of supplies to the paint trade. The raw oil is offered at 78c. per gal. and the boiled at 80c. in cooperage.

NAVAL STORES

The feature of this branch of the trade was the sharp advance in the price of *turpentine*. Today this material is very firm and a good inquiry is noted. Dealers are quoting 67c. per gal. in drums and report a satisfactory volume of business. *Rosins* are only in a moderate request and the G and H grades are offered at \$4.50 per 280 lb. in carlots. *Rosin oil* is slow and the price is unchanged at 45c. per gal. for material in cooperage.

The Iron and Steel Market

PITTSBURGH, July 15, 1921.

The general condition of affairs in the steel market is not sensibly changed by last week's announcements of steel price reductions. Most of the reductions thus formally announced were simply recognition of prices previously made by the open market, through the price cutting route. Taking the trade as a whole, the idea of recent years, of other prices being "cut" prices, is yielding rather slowly, although there have been times in the steel trade when the market price of steel was simply what sellers were getting for it, and the position seems to be a perfectly natural position for a commodity market to occupy.

What is perhaps really significant in the market situation is that there is less talk about "the next reduction" or "the final reduction." The trade seems now to be getting away from the idea that the steel market has simply been moving toward a stable level, one that would be maintained or one from which advances would occur. This means, of course, that expectation has been dwindling that there would be in the not distant future, say within a period of months, one of those steel market phenomena known as "a buying movement," in which buyers changed their tactics and bought farther and farther ahead, being encouraged in this by there being slight price advances from time to time. The outlook now is that for an indefinite time the buying of steel will be merely in keeping with requirements as they develop.

STEEL PRODUCTION

Steel production is at not over about 20 per cent of productive capacity, there having been only a slight downward trend in the past week or two. The average rate of production in June was about 27 per cent. July being traditionally a very dull month in the steel industry, it seems improbable that there will be much if any further decline in production, while an increase can easily occur without there being any great change in general conditions.

A factor that will produce an increase in demand upon the steel mills is liquidation of stocks in the hands of buyers of steel, both of stocks of steel and of manufactures of steel. In the case of the agricultural implement factories the stocks of finished implements are much larger than the stocks of steel. With other manufacturing consumers, as a whole, the balance is probably the other way. The liquidation does not seem to be proceeding very rapidly. In the oil industry there remain some stocks of tubular and other goods, while drilling and other work is very light.

In some quarters predictions are made that the railroads will soon become important buyers, favorably affecting steel mill operations. These predictions seem to be based largely on theory, it being a fact that some men, in most intimate contact with the railroads, refuse to make predictions. The fact may not be as generally known as it should be that the railroads owe the steel mills and some customers of the steel mills quite a large sum of money in the aggregate, and remittances rather than orders are desired first.

It is the common view that the demand upon the steel mills, represented by the rate of production, since almost all orders and specifications received are filled within a very few days, is quite below a normal relation to the general industrial and commercial activity of the country. Of that there is no question, but while the fact of the demand being subnormal in this sense may be quite patent there is no light on the question how long it can remain so. In the past the phenomenon was not observed. Steel mill operations before the war never dropped below about 50 per cent of capacity, and that came to be considered the irreducible minimum. Today's 20 per cent operation is equal to only about 30 per cent operation of the total capacity in existence in 1914.

Pig iron has continued to slide off, declines in the week being about 50c. a ton. The valley market is quotable at about \$21 for bessemer, \$20.50 for foundry and \$19.50 for basic. Freight to Pittsburgh is \$1.96, but it should be noted that basic iron for Pittsburgh delivery, from other sources than the valleys, has been available at 50c. or more below the valley equivalent.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.40 - \$0.45
Acetone.....lb.	\$0.12 - \$0.12	.13 - .13
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99 1/2 per cent, carboys, 100 lbs.	9.75 - 10.00	10.25 - 10.50
Boric, crystals.....lb.	.13 - .14	.14 - .15
Boric, powder.....lb.	.15 - .15	.16 - .16
Citric.....lb.	.45 - .45	.46 - .46
Hydrochloric.....100 lb.	1.50 - 1.65	1.75 - 2.00
Hydrofluoric, 52 per cent.....lb.	.12 - .12	.12 - .13
Lactic, 44 per cent tech.....lb.	.10 - .11	.11 - .12
Lactic, 22 per cent tech.....lb.	.04 - .05	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	.06 - .06	.07 - .07
Nitric, 40 deg.....lb.	.07 - .07	.07 - .07
Nitric, 42 deg.....lb.	.18 - .18	.18 - .19
Oxalic, crystals.....lb.	.13 - .14	.14 - .18
Phosphoric, 50 per cent solution.....lb.	.20 - .25	.27 - .35
Picric.....lb.		1.90 - 2.15
Pyrogallol, resublimed.....lb.		11.75 - 14.00
Sulphuric, 60 deg., tank cars.....ton		13.00 - 15.00
Sulphuric, 60 deg., drums.....ton	18.00 - 20.00	
Sulphuric, 66 deg., tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., drums.....ton		
Sulphuric, 66 deg., carboys.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	31.00 - 32.00	33.00 - 34.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton		.90 - 1.00
Tannin, U. S. P.....lb.	.45 - .48	.50 - .55
Tannin, tech.....lb.		.29 - .30
Tartaric, crystals.....lb.		1.30 - 1.40
Tungstic, per lb. of WO.....gal.		4.80 - 5.00
Alcohol, Ethyl.....gal.		.31 - .36
Alcohol, Methyl (see methanol).....gal.		.38 - .42
Alcohol, denatured, 188 proof.....gal.	.03 - .03	.04 - .04
Alcohol, denatured, 190 proof.....gal.	.03 - .04	.04 - .04
Alum, ammonia lump.....lb.	.10 - .11	.11 - .12
Alum, potash lump.....lb.	.01 - .02	.02 - .02
Alum, chrome lump.....lb.	.03 - .03	.03 - .04
Aluminum sulphate, commercial.....lb.	.07 - .07	.07 - .08
Aluminum sulphate, iron free.....lb.	.30 - .32	.33 - .35
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.08 - .08	.09 - .10
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.06 - .06	.07 - .07
Ammonium carbonate, powder.....lb.	.07 - .08	.08 - .08
Ammonium chloride, granular (white).....lb.	.07 - .07	.07 - .08
Ammonium chloride, granular (gray).....lb.	.07 - .07	.07 - .08
Ammonium nitrate.....lb.	2.70 - 2.75	2.80 - 3.00
Ammonium sulphate.....100 lb.		4.00 - 4.25
Amylacetate.....gal.		2.50 - 3.00
Amylacetate, tech.....gal.	.06 - .07	.07 - .08
Arsenic oxide, (white arsenic) powdered.....lb.	.11 - .11	.12 - .13
Arsenic, sulphide, powdered (red arsenic).....lb.	59.00 - 59.50	60.00 - 62.00
Barium chloride.....lb.	.20 - .21	.22 - .23
Barium dioxide (peroxide).....lb.	.07 - .07	.08 - .08
Barium nitrate.....lb.	.04 - .05	.05 - .06
Barium sulphate (precip.) (blanc fixe).....lb.		
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Bromine.....lb.	.41 - .42	.43 - .45
Calcium acetate.....100 lbs.	2.00 - 2.05	
Calcium carbide.....lb.	.04 - .04	.05 - .05
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01 - .02	.02 - .02
Calcium hypochlorite (bleach powder) 100 lb.....lb.	2.15 - 2.25	2.35 - 2.50
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.75 - .78
Carbon bisulphide.....lb.	.06 - .07	.07 - .08
Carbon tetrachloride, drums.....lb.	.10 - .10	.11 - .12
Carbonyl chloride (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.	.08 - .09	.09 - .10
Chlorine, gas, liquid-cylinders (100 lb.).....lb.		.40 - .43
Chloroform.....lb.		3.00 - 3.10
Cobalt oxide.....lb.		
Copperas (see iron sulphate).....lb.	.19 - .19	.20 - .21
Copper carbonate, green precipitate.....lb.		.50 - .62
Copper cyanide.....lb.	.05 - .06	.06 - .06
Copper sulphate.....lb.		
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		.85 - 1.00
Ethyl Acetate Com. 85%.....gal.		
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	.13 - .13	.13 - .14
Formaldehyde, 40 per cent.....gal.		3.00 - 3.25
Fusel oil, crude.....gal.		1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.		.15 - .15
Glycerine, C. P. drums extra.....lb.		3.65 - 3.75
Iodine, resublimed.....lb.		.10 - .20
Iron oxide, red.....lb.		
Iron sulphate (copperas).....ton	19.00 - 20.00	21.00 - 22.00
Lead acetate.....lb.	.09 - .09	.10 - .11
Lead arsenate, paste.....lb.		.15 - .20
Lead nitrate.....lb.	.08 - .08	.08 - .09
Litharge.....lb.		1.30 - 1.40
Lithium carbonate, technical.....lb.	.09 - .09	.10 - .11
Magnesium carbonate, technical.....lb.	2.40 - 2.75	
Magnesium sulphate, U. S. P.....100 lb.		1.20 - 1.25
Magnesium sulphate, technical.....100 lb.		.77 - .80
Methanol, 95%.....gal.		.80 - .85
Methanol, 97%.....gal.		.12 - .12
Nickel salt, double.....lb.		.14 - .14
Nickel salt, single.....lb.		
Phosgene (see carbonyl chloride).....lb.	.45 - .46	.47 - .50
Phosphorus, red.....lb.		.35 - .37
Phosphorus, yellow.....lb.	.11 - .11	.12 - .12
Potassium bichromate.....lb.		

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35	\$.40
Potassium bromide, granular..... lb.	.05	.05
Potassium carbonate, U. S. P..... lb.	.05	.05
Potassium carbonate, 80-85%..... lb.	.07	.07
Potassium chlorate, crystals..... lb.	.05	.05
Potassium cyanide..... lb.	.05	.05
Potassium hydroxide (caustic potash)..... lb.	.05	.05
Potassium muriate, 80% K.C.L..... ton	45.00	50.00
Potassium iodide..... lb.	.09	.09
Potassium nitrate..... lb.	.29	.30
Potassium permanganate..... lb.	.30	.31
Potassium prussiate, red..... lb.	.22	.22
Potassium prussiate, yellow..... lb.	.22	.22
Potassium sulphate (powdered)..... per unit	1.50	1.75
Rochelle salts (see sodium potas. tartrate).....		
Salammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake..... ton	23.00	25.00
Silver cyanide..... oz.	1.35	1.38
Silver nitrate..... oz.	.40	.41
Soda ash, light..... 100 lb.	2.00	2.10
Soda ash, dense..... 100 lb.	2.35	2.40
Sodium acetate..... lb.	.04	.04
Sodium bicarbonate..... 100 lb.	2.25	2.40
Sodium bichromate..... lb.	.08	.08
Sodium bisulphate (nitre cake)..... ton	5.00	5.25
Sodium bisulphate powdered, U.S.P..... lb.	.05	.05
Sodium borate (borax)..... lb.	.06	.06
Sodium carbonate (salt soda)..... 100 lb.	1.90	2.00
Sodium chlorate..... lb.	.07	.07
Sodium cyanide..... lb.	.19	.21
Sodium fluoride..... lb.	.11	.12
Sodium hydroxide (caustic soda)..... 100 lb.	4.00	4.10
Sodium hyposulphite..... lb.	.03	.03
Sodium nitrate..... 100 lb.	2.90	3.00
Sodium nitrite..... lb.	.07	.07
Sodium peroxide, powdered..... lb.	.25	.26
Sodium phosphate, dibasic..... lb.	.04	.04
Sodium potassium tartrate (Rochelle salts)..... lb.	.12	.12
Sodium prussiate, yellow..... lb.	.12	.12
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00	1.15
Sodium silicate, solution (60 deg.)..... lb.	.02	.03
Sodium sulphate, crystals (Glauber's salt) 100 lb.	1.50	1.75
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05	.05
Sodium sulphite, crystals..... lb.	.03	.04
Srtrontium nitrate, powdered..... lb.	.15	.15
Sulphur chloride, red..... lb.	.07	.07
Sulphur, crude..... ton	20.00	22.00
Sulphur dioxide, liquid, cylinders extra..... lb.	.08	.08
Sulphur (sublimed), flour..... 100 lb.		2.25
Sulphur, roll (brimstone)..... 100 lb.		2.00
Tin bichloride, 50 per cent..... lb.	.18	.19
Tin oxide..... lb.		.40
Zinc carbonate, precipitate..... lb.	.15	.16
Zinc chloride, gran..... lb.	.11	.11
Zinc cyanide..... lb.	.45	.49
Zinc dust..... lb.	.11	.11
Zinc oxide, XX..... lb.	.07	.07
Zinc sulphate..... 100 lb.	3.00	3.25

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10	\$1.15
Alpha-naphthol, refined..... lb.	1.25	1.30
Alpha-naphthylamine..... lb.	.35	.40
Aniline oil, drums extra..... lb.	.20	.26
Aniline salts..... lb.	.25	.28
Anthracene, 80% in drums (100 lb.)..... lb.	.75	1.00
Benzaldehyde U.S.P..... lb.	1.50	
Benzidine, base..... lb.	.85	1.00
Benzidine sulphate..... lb.	.75	.85
Benzoic acid, U.S.P..... lb.	.65	.65
Benzoate of soda, U.S.P..... lb.	.55	.60
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27	.32
Benzene, 90%, in drums (100 gal.)..... gal.	.25	.28
Benzyl chloride, 95-97%, refined..... lb.	.28	.30
Benzyl chloride, tech..... lb.	.20	.25
Beta-naphthol benzoate..... lb.	3.50	4.00
Beta-naphthol, sublimed..... lb.	.70	.75
Beta-naphthol, tech..... lb.	.35	.38
Beta-naphthylamine, sublimed..... lb.	1.75	1.80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16	.18
Ortho-cresol, in drums (100 lb.)..... lb.	.25	.27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.65	.70
Cresylic acid, 95-97%, dark, in drums..... gal.	.45	.50
Cresylic acid, 50%, first quality, drums..... lb.	.06	.09
Dichlorobenzene..... lb.	1.20	1.25
Diethylaniline..... lb.	.38	.48
Dimethylaniline..... lb.	.26	.28
Dinitrobenzene..... lb.	.20	.30
Dinitrochlorobenzene..... lb.	.30	.40
Dinitronaphthalene..... lb.	.35	.40
Dinitrophenol..... lb.	.27	.30
Dinitrotoluene..... lb.	.40	.45
Dip oil, 25%, car lots, in drums..... gal.	.60	.65
Diphenylamine..... lb.	1.20	1.30
H-acid..... lb.	1.15	1.20
Meta-phenylenediamine..... lb.	.12	.14
Monochlorobenzene..... lb.	1.75	1.85
Monoethylaniline..... lb.	.07	.08
Naphthalene crushed, in bbls..... lb.	.07	.08
Naphthalene, flake..... lb.	.08	.09
Naphthalene, balls..... lb.	.70	.75
Naphthionic acid, crude..... lb.	.12	.15
Nitrobenzene..... lb.	.30	.35
Nitronaphthalene..... lb.	.16	.18
Nitro-toluene..... lb.	3.15	3.20
Ortho-amidophenol..... lb.	.80	.85
Ortho-dichlorobenzene..... lb.	.15	.20
Ortho-nitro-phenol..... lb.	.15	.20
Ortho-nitro-toluene..... lb.	1.20	1.25
Ortho-toluidine..... lb.	1.50	1.60
Para-amidophenol, base..... lb.	1.60	1.75
Para-amidophenol, HCl..... lb.		

Para-dichlorobenzene..... lb.	.15	.20
Paranitroaniline..... lb.	.82	.90
Para-nitrotoluene..... lb.	.85	.95
Para-phenylenediamine..... lb.	1.75	2.00
Para-toluidine..... lb.	1.25	1.40
Phthalic anhydride..... lb.	.50	.60
Phenol, U. S. P., drums..... lb.	.09	.11
Pyridine..... gal.	2.00	3.50
Resorcinol, technical..... lb.	1.75	1.85
Resorcinol, pure..... lb.	2.25	2.30
Salicylic acid, tech., in bbls..... lb.	.19	.22
Salicylic acid, U. S. P..... lb.	.20	.25
Salol..... lb.	.80	.85
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25	.28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14	.16
Sulphanilic acid, crude..... lb.	.30	.35
Tolidine..... lb.	1.25	1.35
Toluidine, mixed..... lb.	.40	.45
Toluene, in tank cars..... gal.	.25	.28
Toluene, in drums..... gal.	.28	.31
Xylidines, drums, 100 gal..... lb.	.40	.45
Xylene, pure, in drums..... gal.	.40	.45
Xylene, pure, in tank cars..... gal.	.45	.50
Xylene, commercial, in drums, 100 gal..... gal.	.33	.35
Xylene, commercial, in tank cars..... gal.	.30	

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24	\$0.25
Beeswax, refined, light..... lb.	.27	.28
Beeswax, white pure..... lb.	.42	.45
Carnauba, Florida..... lb.	.58	.60
Carnauba, No. 2, North Country..... lb.	.25	.26
Carnauba, No. 3, North Country..... lb.	.13	.14
Japan..... lb.	.16	.16
Montan, crude..... lb.	.06	.06
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03	.03
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02	.03
Paraffine waxes, refined, 116-120 m.p..... lb.	.03	.03
Paraffine waxes, refined, 125 m.p..... lb.	.03	.04
Paraffine waxes, refined, 128-130 m.p..... lb.	.04	.04
Paraffine waxes, refined, 133-135 m.p..... lb.	.05	.05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05	.06
Stearic acid, single pressed..... lb.	.09	.09
Stearic acid, double pressed..... lb.	.09	.10
Stearic acid, triple pressed..... lb.	.10	.10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.10	
Rosin E-I..... 280 lb.	5.20	5.45
Rosin K-N..... 280 lb.	5.70	6.75
Rosin W. G.-W. W..... 280 lb.	7.35	
Wood rosin, bbl..... 280 lb.	6.25	
Spirits of turpentine..... gal.	.67	
Wood turpentine, steam dist..... gal.	.60	
Wood turpentine, dest. dist..... gal.	.58	
Pine tar pitch, bbl..... 200 lb.		7.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.		11.50
Retort tar, bbl..... 500 lb.		11.50
Rosin oil, first run..... gal.	.35	
Rosin oil, second run..... gal.	.37	
Rosin oil, third run..... gal.	.41	
Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	\$1.80	
Pine oil, pure, dest. dist..... gal.	1.50	
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46	
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35	
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75	
Pine tar, ref., thin, sp.gr., 1.080-1.060..... gal.	.35	
Turpentine, crude, sp.gr., 0.900-0.970..... gal.	1.20	
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35	
Pinewood creosote, ref..... gal.	.52	

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.16	.17
Upriver coarse..... lb.	.09	.09
Upriver caucho ball..... lb.	.11	.12
Plantation—First latex crepe..... lb.	.14	
Ribbed smoked sheets..... lb.	.12	.12
Brown crepe, thin, clean..... lb.	.15	
Amber crepe No. 1..... lb.	.17	

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08	\$0.09
Castor oil, AA, in bbls..... lb.	.10	.10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.12	.12
Cocanut oil, Ceylon grade, in bbls..... lb.	.10	.10
Cocanut oil, Cochinchina grade, in bbls..... lb.	.10	.11
Corn oil, crude, in bbls..... lb.	.07	.08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07	.07
Cottonseed oil, summer yellow..... lb.	.07	.08
Cottonseed oil, winter yellow..... lb.	.08	
Linseed oil, raw, car lots (domestic)..... gal.	.71	.72
Linseed oil, raw, tank cars (domestic)..... gal.	.65	.66
Linseed oil, in 5-bbl lots (domestic)..... gal.	.73	.74

Olive oil, Denatured.....	gal.	\$1.35	—	\$1.45
Palm, Lagos.....	lb.	.06	—	.06
Palm, Niger.....	lb.	.05	—	.05
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.88	—	.90
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls, N. Y.....	lb.	.07	—	.07
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	.06

FISH

Light pressed menhaden.....	gal.	\$0.42	—	—
Yellow bleached menhaden.....	gal.	.44	—	—
White bleached menhaden.....	gal.	.46	—	—
Blown menhaden.....	gal.	.50	—	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	—
Blanc fixe, dry.....	lb.	.04	—	.04
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.08	—	.10
Chalk, domestic, extra light.....	lb.	.04	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04
Chalk, domestic, heavy.....	lb.	.03	—	.04
Chalk, English, extra light.....	lb.	.04	—	.05
Chalk, English, light.....	lb.	.04	—	.05
Chalk, English, dense.....	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	25.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Miras.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, fis. quality.....	lb.	.07	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06
Graphite, high grade amorphous crude.....	lb.	.02	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	—	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.67	—	—
Shellac, orange superfine.....	lb.	.66	—	.67
Shellac, A. C. garnet.....	lb.	.53	—	.54
Shellac, T. N.....	lb.	.58	—	.60
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50-40.00	—	—
Carborundum refractory brick, 9-in.....	1,000	1250.00	—	—
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60	—	—
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32	—	—
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33-35	—	—
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36-40	—	—
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35	—	—
Magnesite brick, 9-in. straight.....	net ton	70	—	—
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	—
Magnesite brick, soaps and splits.....	net ton	98	—	—
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42-45	—	—
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46-50	—	—
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38	—	—

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14	—	—
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	—	—
Ferromanganese, 76-80% Mn, domestic.....	gross ton	70.00	—	75.00
Ferromanganese, 76-80% Mn, English.....	gross ton	75.00	—	75.00
Spiegeleisen, 18-22% Mn.....	gross ton	27.00	—	28.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	—
Ferrosilicon, 10-15%.....	gross ton	40.00	—	42.00
Ferrosilicon, 50%.....	gross ton	68.00	—	70.00
Ferrosilicon, 75%.....	gross ton	135.00	—	138.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferrouranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	—
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	4.50	—	5.00

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.30	—	.33
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.30	—	.33
Coke, foundry, f.o.b. ovens.....	net ton	4.00	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75	—	3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00	—	15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50	—	—
Fluorspar, standard, domestic washed gravel.....	net ton	18.00	—	20.00
Kentucky and Illinois mines.....	lb.	.01	—	.01
Ilmenite, 52% TiO ₂ , per lb. ore.....	unit	.25	—	—
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	gross ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	—
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	—
Zircon, washed, iron free.....	lb.	.03	—	—

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....	lb.	12.75
Aluminum, 98 to 99 per cent.....	lb.	28.00 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	lb.	.41
Nickel, ordinary (ingot).....	lb.	41.00
Nickel, electrolytic.....	lb.	44.00
Morrel me al, spot and bunks.....	lb.	35.00
Morrel me al, ingots.....	lb.	38.00
Morrel metal, sheet bars.....	lb.	40.00
Tin, 5-ton lots, Straits.....	lb.	28.25
Lead, New York, spot.....	lb.	4.45-4.50
Lead, E. St. Louis, spot.....	lb.	4.30-4.35
Zinc, spot, New York.....	lb.	4.60-4.65
Zinc, spot, E. St. Louis.....	lb.	4.25-4.30

OTHER METALS

Silver (commercial).....	oz.	\$0.60
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00 @ 75.00
Iridium.....	oz.	160.00 @ 180.00
Palladium.....	oz.	60.00-65.00
Mercury.....	75 lb.	45.00-46.00

FINISHED METAL PRODUCTS

Warehouse Price Cents per Lb.

Copper sheets, hot rolled.....	20.75-21.25
Copper bottoms.....	28.25-28.75
Copper rods.....	19.75-20.00
High brass wire.....	16.75
High brass rods.....	13.75
Low brass wire.....	18.25
Low brass rods.....	18.25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	21.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.25 @ 9.50	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.25 @ 7.75	7.50	7.25
Lead, heavy.....	3.25 @ 3.50	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.25 @ 4.50	4.25	4.50
Zinc.....	2.00 @ 2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.38	\$3.00	\$3.00
Soft steel bars.....	2.28	2.80	2.80
Soft steel bar shapes.....	2.28	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, 1/2 to 1 in. thick.....	2.38	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—E. W. Barrett, Birmingham, and associates are organizing a new company for the construction of a paper mill in this section. The proposed plant is estimated to cost in excess of \$750,000, including machinery.

California

ORANGE—The California Wire Co., recently organized, is planning for the erection of a new local plant, 80 x 135 ft., for the manufacture of wire products. Louis Koth is president.

Connecticut

STAMFORD—The H. & H. Foundry & Machine Co. is planning for the rebuilding of the portion of its plant, destroyed by fire, July 4, with loss estimated at about \$25,000.

Delaware

YORKLYN—The National Fibre & Insulation Co. has awarded a contract to S. W. N. Worrell, Kennett Sq., Chester, Pa., for the erection of a new 2-story building, 139 x 160 ft. Work will be commenced at once.

Florida

APOPKA—The Florida Insecticide Co. is planning for the rebuilding of its plant, recently destroyed by fire with loss estimated at about \$22,000. J. C. Grossenbacher is manager.

JACKSONVILLE—The American Oil Co. is planning for the construction of a new branch plant for the manufacture of oil products. The company will also build a storage works in the Commodore's Point section.

PALATKA—The United Sugar Corp. has preliminary plans under way for the erection of a new refining plant. H. A. Jones is local manager.

Illinois

CHICAGO—The G-A Ball Bearing Mfg. Co., 3051 West Lake St., manufacturer of steel ball bearings, etc., has completed plans for the erection of a 1-story addition, 210 x 230 ft. at Lake and Albany Sts., estimated to cost about \$65,000. Burrett H. Stephens, 300 Old Colony Bldg., is architect.

Indiana

WHITING—Fire, July 4, destroyed a large portion of the local plant of the Standard Oil Co. of Indiana, Indianapolis, with loss including equipment, estimated at close to \$2,000,000.

NOBLESVILLE—The N. O. Nelson Mfg. Co., 928 Chestnut St., St. Louis, Mo., manufacturer of enameled plumbing fixtures, etc., is completing plans for extensions and improvements in its plant at Noblesville, to cost about \$50,000. The enameling furnaces at the works will be improved, and a new power house erected. Victor J. Azbe, 2194 Railway Exchange Bldg., St. Louis, is engineer.

TERRE HAUTE—The Turner Glass Co. is reported to be planning for the rebuilding of the portion of its plant destroyed by fire, July 3, with loss estimated at \$40,000.

ELKHART—The American Coating Mills, manufacturer of coated papers, has awarded miscellaneous contracts for the erection and completion of its proposed new 3-story plant at the foot of Division St., to be 50 x 150 ft., with extension, 50 x 50 ft., estimated to cost about \$600,000 with equipment. It will be known as Plant No. 2. James L. Carey, 208 North Laramie St., Chicago, Ill., is engineer.

ALEXANDRIA—The Lippincott Glass Co. has discontinued operations at its local plant for the summer season. Machinery and equipment will be repaired and improved during the curtailment.

Kentucky

ASHLAND—In connection with the erection of its proposed new plant, the Mayo Oil Service Co. will operate a works for the manufacture of soaps, oils and other specialties. It will be located at Front and Eleventh Sts. John C. C. Mayo is president and treasurer.

Maryland

BALTIMORE—The Adamantex Brick Co. of Maryland, recently organized with a capital of \$1,000,000, has plans under way for the erection of a new plant at Arbutus, Md., for the manufacture of sand-cement bricks and affiliated products. It is proposed to develop a capacity of about 240,000 bricks per day. The company is connected with a concern of like name of New York, operating a plant in Brooklyn. It is represented locally by Blum & Makover, Equitable Bldg.

Massachusetts

MALDEN—The Potter Drug & Chemical Corp. is having plans prepared for the erection of a new 2-story building on Medford St., brick and reinforced concrete, 50 x 85 ft.

ABINGTON—Stone & Keller, Brockton, Mass., have leased a local building on Vernon St., and will install equipment at once for the manufacture of rubber cement and kindred specialties. It is proposed to inaugurate operations at an early date.

Mississippi

GULFPORT—The Gulf Coast Oil Refining Co., recently organized with a capital of \$100,000, has leased a site totaling about 20 acres for the erection of its proposed new plant. Initial work will consist of tank installation. George L. Dodds is president, and Charles T. Madison, vice-president and general manager.

Nebraska

ANTIOCH—The Nebraska Potash Works Co. is planning for the rebuilding of the portion of its plant destroyed by fire, July 2, with loss estimated at about \$250,000, including equipment.

New Jersey

MILLVILLE—The F. C. Wheaton Co., specializing in the manufacture of druggists' glassware specialties, has discontinued operations at its plant for the summer season.

New York

LONG ISLAND CITY—The Mirrorlike Mfg. Co., 203 Eighth St., manufacturer of polishes, has acquired property at the Queens Blvd. and Buckley St., 100 x 140 ft., for the erection of a new 2-story building to occupy the entire site.

HUDSON—The International Cement Co., Boston, Mass., has acquired the property and business of the Knickerbocker Portland Cement Co. The company operates a large mill here.

CORNING—Fire, July 7, destroyed a portion of the plant of the Corning Brick, Terra Cotta & Tile Co., with loss estimated at about \$40,000.

SYRACUSE—The Atmospheric Nitrogen Co., affiliated with the Solvay Process Co. and the Semet-Solvay Co., is planning for the early operation of its new local plant, with initial output to total about 20,000 lb. of anhydrous ammonia per day. This first plant unit will represent an investment of close to \$3,000,000, and will be followed at a later date by a number of other plant units, tentative plans for which have been prepared.

NEW YORK—The B. F. Goodrich Co., manufacturer of tires and rubber goods, with plant at Akron, O., has organized a subsidiary company, to be known as the International B. F. Goodrich Co.; the company will take over all plants of the parent organization located at European points, and in the future will operate the properties. The subsidiary is capitalized at \$10,000,000, with local offices at 1780 B'way.

North Carolina

HENDERSON—J. H. Brodie has commenced the erection of a new 1-story plant, 60 x 100 ft., to be equipped for the manufacture of fertilizer products. It is estimated to cost about \$35,000.

Ohio

CLEVELAND—The Noble Refining Co., 706 Canal Rd., has awarded a contract to the Girard Construction Co., Arcade Bldg., for the erection of its proposed new oil-refining plant at Elk Ave. and East Ninth St., to be 1-story and basement, and estimated to cost about \$85,000. A power house will also be constructed. A. Ritman is president.

Pennsylvania

WILLIAMSPORT—William Ditmar, Williamsport, has tentative plans under way for the erection of his proposed new local plant for the manufacture of composition tile products and similar specialties.

JOHNSTOWN—The Lee Strauss Chemical Co., Vine St., has broken ground for the erection of a new 5-story building, 44 x 165 ft., on Levergood St. The Thiele Construction Co., Johnstown, has the building contract. Edward G. Strauss is president.

Tennessee

NASHVILLE—The Victoria Oil & Refining Co. is planning for the rebuilding of the portion of its plant, used for distilling and other service, with loss estimated at about \$25,000.

MT. PLEASANT—The Phosphates Products Co., recently organized, has plans under way for the erection of its proposed new phosphate works, estimated to cost about \$35,000. The plant will have departments for the manufacture of lumen material, ground phosphate rock and kindred products. E. E. Fish is secretary and treasurer. James A. Barr, Mt. Pleasant, is construction engineer for the work.

Virginia

MONEY POINT, PORTSMOUTH—Swift & Co., Union Stock Yards, Chicago, Ill., are reported to be planning for the construction of a new plant on a local site, estimated to cost over \$500,000, for the manufacture of fertilizer products. Tentative plans are being drawn.

FRONT ROYAL—Samuel Wine has leased a tract of local property for the development of lead and silver. Machinery for operation will be installed at an early date.

Washington

TACOMA—The National Coconut Oil Co., Tacoma, is now operating at the former plant of the Columbia Brewing Co., and has remodeled the structure to accommodate the new line of business. Production will be devoted to laundry soaps, washing powders, etc. William Virges is president; D. K. Derrickson is secretary and treasurer.

West Virginia

MORGANTOWN—The University of West Virginia has commissioned Architect Paul A. Davis 3rd, 1713 Sansome St., Philadelphia, Pa., to prepare plans for the proposed new chemical laboratory at the institution, estimated to cost about \$400,000.

Quebec

AMOS—The Frank Blais Co. is planning for the rebuilding of its pulpwood plant, recently damaged by fire, with loss estimated at about \$12,000.

New Companies

THE WATERWAY PAPER PRODUCTS CO., 3221 South Kedzie St., Chicago, Ill., has been incorporated with a capital of \$500,000 to manufacture paper goods. The incorporators are John P. Barnes, Guy C. Baltz and Arthur L. Schwartz.

THE CENTRAL WEST GREASE CO., St. Joseph, Mo., has been incorporated with a capital of \$50,000 to manufacture greases, lubricants, etc. A. B. Snoddy is president, and G. F. Bigelow secretary and treasurer, both of St. Joseph.

CRONKHITE, SANDS & CO., INC., Boston, Mass., has been incorporated with a capital of 500 shares of stock, no par value, to manufacture chemicals, soaps and kindred products. Leonard W. Cronkhite, 142 Berkeley St., is president and treasurer; Warren Sands is vice-president.

THE PENNIE ANTE OIL CO., Los Angeles, Cal., has been incorporated with a capital

of \$200,000 to manufacture petroleum products. The incorporators are L. P. Jones, R. I. Plomert and Joseph M. Howell. The company is represented by David P. Hatch, 1121 I. N. Van Nuys Bldg., Los Angeles.

THE FRANKLIN PAPER BAG MFG. CO., Woodstown, N. J., has been incorporated with a capital of \$300,000 to manufacture paper bags and containers. The incorporators are James M. Clawson, Woodstown; Frank A. Cabeen, Jr., Haverford, Pa.; and James H. Young, Land Title Bldg., Philadelphia, Pa.

THE NEW JERSEY CHEMICAL & RUBBER WORKS, INC., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture rubber products, chemicals and affiliated specialties. The incorporators are Meyer E. Gusman, Nathaniel Ginsburg and Jacob Janoff. The company is represented by A. Milton Jacobs, 9 Clinton St.

THE OLD COLONY CHEMICAL CO., Avon, Mass., has been incorporated with a capital of \$5,000 to manufacture chemicals and chemical byproducts. William I. Gay is president, and Howard L. Baker, Kingston, Mass., treasurer.

THE NUTINT CO., Philadelphia, Pa., has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. M. A. Weisbard, 202 East Allegheny Ave., is treasurer.

THE COMMON SENSE POLISH CO., Los Angeles, Cal., has been incorporated with a capital of \$10,000 to manufacture polishes and kindred specialties. The incorporators are J. E. Lloyd, H. T. Hurley and L. E. Cummings. The company is represented by Wetherbore, Hoyt & Jones, Title Insurance Bldg.

THE SANITARY REDUCTION CO., 35 Central Savings Bank Bldg., Baltimore, Md., has been incorporated with a capital of \$400,000, to manufacture fertilizer products. The incorporators are Joseph G. Johnson and J. Carroll Dailey.

THE BORRERDARD CO., New York City, has been incorporated with a capital of \$10,000 to manufacture pulp and paper products. The incorporators are H. Wessel, A. Olafson and A. Marc Barnes, Jr. The company is represented by Barnes, Chilvers & Halstead, 2 Rector St.

THE M. & B. OIL CO., Hoboken, N. J., has been incorporated with a capital of \$100,000 to manufacture and deal in refined oils. The incorporators are Claude M. Morrison, Jesse M. Parshall and Max Blackman. The company is represented by Tackella, Camby & Stiles, 95 River St.

THE ULTRA CHEMICAL CO., 182 Washington St., Newark, N. J., has filed notice of organization to manufacture chemical specialties. E. Manias heads the company.

THE COLUMBUS FOUNDRY CO., Columbus, Ga., has been incorporated with a capital of \$10,000 to manufacture iron and other metal castings. The incorporators are J. B. Knight, Jr., and C. H. Cox, Columbus.

THE S. P. BRICK & TILE CO., Fresno, Cal., has been incorporated with a capital of \$250,000 to manufacture brick, tile and other burned clay products. The incorporators are W. H. Shields, Fresno; W. D. Trehwitt, Hanford, Cal., and L. E. Hayes, Exeter, Cal.

THE BEACON DRUG & CHEMICAL CO., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture chemicals, byproducts, drugs, etc. Isaac H. Bernstein, 71 Homestead St., Roxbury, Mass., is treasurer; Joseph Golden is president.

THE METAL MATERIALS CO., Asbury Park, N. J., has been incorporated with a capital of \$125,000 to manufacture metalware products. The incorporators are Roscoe G. Tagle, Frank V. B. Young and Isaiah Matlack, 601 Mattison Ave.

THE NATIONAL HUMUS & CHEMICAL CO., Chassell, Mich., has been incorporated with a capital of \$1,000,000 to manufacture fertilizer products. The incorporators are Claude F. Hancock, Chassell; Roy Herliad and Donald I. L. Baugh, Detroit, Mich.

THE SODDER-RITE CO., New York City, has been incorporated with a capital of \$5,000 to manufacture chemical specialties. The incorporators are L. J. Jones, F. E. Lampe and H. Kleinigeris. M. Gollubier, 255 East 149th St., represents the company.

THE WHITTIER POINT OIL CO., Whittier, Cal., has been incorporated with a capital of \$150,000 to manufacture petroleum products. The incorporators are H. H. Witte, Fred G. Phillips and L. F. Ranker, all of Pomona, Cal. The company is represented by E. B. Coil, attorney, Santa Monica, Cal.

THE INTERLOCKING TILE & SEWER PIPE CO., Indio, Cal., has been incorporated with

a capital of \$250,000 to manufacture sewer pipe, tile and other burned clay products. J. A. Gordon is president; J. A. Nelson, vice-president; and J. W. Wilson, treasurer.

THE HOPKINS MASTER CLEANER, INC., Boston, Mass., has been incorporated with a capital of \$20,000 to manufacture cleansing compounds, and kindred products. Alfred Hopkins is president; Howard Knowles, 13 Waterhouse St., Cambridge, Mass., is treasurer.

THE WIS CHEMICAL & DRUG CO., Utica, N. Y., has been incorporated with a capital of \$10,000 to manufacture chemicals and affiliated products. The incorporators are C. C. Allison, P. M. Risinger and C. S. Horsburgh. H. D. Williams, Utica, represents the company.

THE RIVERSIDE BAPTISTE OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are M. W. W. Reitz, J. Sickman and W. H. Dehm, California Bldg.

THE AMERICAN LEATHER MFG. CO., 166 Tichenor St., Newark, N. J., has filed notice of organization to manufacture leather products. John Lipp, 36 Boyd St., heads the company.

THE MIT-SHEL STAMPING & MFG. CO., 510 Jersey St., Quincy, Ill., has been incorporated with a capital of \$50,000, to manufacture stamped metal goods. The incorporators are Edward H. Mitchell, Theodore Schell and William Spohr, Jr.

THE PATUXENT GUANO CO., 407 Vickers Bldg., Baltimore, Md., has been incorporated with a capital of \$75,000 to manufacture fertilizer products. The incorporators are Harry T. Deford, Carroll W. Clark and William E. Gardner.

THE BOONTON CHEMICAL CORP., New York City, has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are J. Michaels, H. M. Cassidy and A. M. Hamburg, 63 Wall St.

THE ARDEN CHEMICAL CO., New York City, has been incorporated with a capital of \$500,000 to manufacture chemicals and chemical byproducts. The incorporators are F. O'Leary, F. Delaney and B. Marks, 320 B'way.

THE HIDECKER BRICK CO., Los Angeles, Cal., has been incorporated with a capital of \$10,000 to manufacture brick and other burned clay products. The incorporators are G. C. Hidecker, Charles W. DeWitt and William Lewis, 504 Bryson Bldg.

THE BERG CHEMICAL CO., New York City, has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are H. M. Monness, J. Fischer and L. Goldberg. The company is represented by J. Wilzin, 35 Nassau St.

Capital Increases, etc.

THE AMERICAN TANNING CO., 1282 West North Ave., Chicago, Ill., manufacturer of leather products, has filed notice of increase in capital from \$50,000 to \$100,000.

THE MUTUAL CHINA CO., Indianapolis, Ind., has filed notice of increase in capital from \$100,000 to \$200,000.

A petition in bankruptcy has been filed against the ATRIKEN CHEMICAL WORKS, 75 John St., New Brunswick, N. J. The liabilities are stated at \$100,000, and assets \$40,000.

THE DESMOND CHARCOAL & CHEMICAL CO., Detroit, Mich., has filed notice of dissolution under state laws.

THE PRESTO CHEMICAL CO., Detroit, Mich., has filed notice of increase in capital from \$25,000 to \$150,000.

THE CENTRAL PENNSYLVANIA OIL CO., Nazareth, Pa., has filed notice of increase in capital from \$200,000 to \$600,000.

THE BECKER PAPER CO., Fort Wayne, Ind., has filed notice of increase in capital from \$50,000 to \$100,000.

THE CENTRAL GLASS CO., Louisville, Ky., has filed notice of increase in capital from \$1,000,000 to \$1,250,000.

THE AMERICAN EAGLE RUBBER CEMENT CO., 3026 South La Salle St., Chicago, Ill., has filed notice of change of name to the Rubber & Cements Co., Inc.

THE NOVELTY LEATHER WORKS, Jackson, Mich., has filed notice of dissolution under state laws.

THE OIL CITY BRASS WORKS, Neaumont, Tex., has filed notice of increase in capital from \$5,000 to \$50,000.

Manufacturers' Catalogs

THE C. W. HUNT ENGINEERING CORP., New York City, calls attention to a four-page booklet on self-aligning all steel troughing belt conveyor idler.

THE READING IRON CO., Reading, Pa., calls attention to Bulletin 2, in which is described, in as simple a manner as possible, the structural difference between wrought iron and steel and their relation to the field of welded pipe. The bulletin has been written to interest the layman as well as the engineer.

HARBISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., announces a leaflet on Metakase Magnesite Brick for Open Hearth Furnaces.

THE BRITISH ALUMINUM CO., LTD., has published a booklet on "The Casting of Aluminum" which contains information of interest to foundrymen, such as proper mixtures for common aluminum castings, melting practice, precautions in molding, shrinkage allowances, finishing and testing.

THE THWING INSTRUMENT CO., Philadelphia, Pa., desires to announce Bulletin 10. This treats of Type A thermoelectric pyrometers, temperatures from 100 deg. C. (200 deg. F.) to 1,600 deg. C. (2,900 deg. F.), base metal couples in three alloys, and platinum couples for highest temperatures. It describes full equipment and furnace mountings, such as protection tubes, junction boxes, selector switches and high resistance galvanometers, both indicating and recording.

THE WILL CORP., Rochester, Mass., has recently published two bulletins. The first, entitled "Water Stills," presents an outline of laboratory stills now in use and goes into the merits of the various makes and types. The second, entitled "The Ion-O-Meter," is a descriptive pamphlet on the measurement of hydrogen ions and the practical application of the Ion-O-Meter to industrial and laboratory problems.

THE WEBSTER MFG. CO., Chicago, Ill., in its June, 1921, issue of "Webster Method" has illustrated articles on "Perkins Pivoted Bucket Carrier in a Modern Cement Plant," "Conover-McHenry Grain Elevator," and "A Five-Track Steel Coal Tipple."

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.